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Roland Traunmüller,
Erszébet Csuháj-Varjú (eds.)

Telecooperation

Proceedings of the XV. IFIP World Computer Congress, 31 August - 4 September 1998, Vienna/Austria and Budapest/Hungary

Österreichische Computer Gesellschaft
(Austrian Computer Society) on behalf of the
International Federation for Information Processing

Telecooperation

Proceedings

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Edited by

Roland Traunmüller
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Österreichische Computer Gesellschaft (OCG) 1998

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Introduction by the IFIP President

I take great pleasure to welcome you to the 15th IFIP World Computer Congress on "The Global Information Society on the Way to the Next Millennium".

This Flagship event of the International Federation for Information Processing (IFIP) is a product of the active involvement of hundreds of IT specialists and many national computer societies around the globe. Ist program and agendas are targeted at topical areas of information processing intended to catch your interest and stimulate debate to suit the needs of IT professionals from academia and industry alike.

The debate will aim to disclose the current state-of-the-art and to project the trends for new developments, which will transcend the threshold of the 21st century and lead society in the magic future of technology.

Moreover, the venues of this IFIP Congress are in the heart of Europe. Vienna and Budapest are historical, cultural and technological crossroads of achievement and civilization. These beautiful cities host the IFIP Congress which in turn provides a forum and a platform for people to meet and discuss issues of common interest and concern.

I hope that you will benefit from this exceptional IFIP Event for your daily work and that you have opportunity during the Congress meeting old friends and making many new ones.

Kurt Bauknecht,
University of Zurich,
President of the International Federation for Information Processing - IFIP

Introduction by the Chairman of the International Program Committee

I am proud to be able to present this technical program. Out of more than 700 contributions from 86 countries, the program committees of the 7 conferences have carefully selected 350 papers, which are presented at the conference and printed in this proceeding

The conferences which you are allowed to switch from one to another cover the main technical aspects of the global information society, like basic theories in the Fundamentals and IT&Knows conference, the hot topics security and legal conditions using net and computers, and important applications such as teleteaching, telecooperation and the use of computers by people with special needs. In the keynote sessions, outstanding experts will introduce the fundamental technologies which made and will continue to make information society possible.

The congress is accompanied by a set of panels, tutorials and workshops. I would like to draw your special attention to the Youth Summit. It will be for the first time that young people will have the opportunity to articulate their views and expectations to the IT community and politicians.

The program gives a good opportunity to study the major technologies and applications which will be the base of future society and to discuss its impact with colleagues from more than 80 countries of our globe.

I hope you enjoy the program, which was so carefully assembled by about 200 ladies and gentlemen in the various program committees, and that your attendance at the congress will have a positive impact on your professional work.

Furthermore, I am sure, that this proceeding will gain a good position in your personal technical library.

Egon Hörbst
Siemens AG Munich,
Technical University of Munich,
International Program Committee Chair

usage. Full benefits of technology will only be reaped if work and organizations will be reshaped. So in the end both, users and organization, will earn substantial profit from change. Breathtaking prospects of new potentialities have already appeared on the horizon. The sign posts directing to them bear well-known labels: Electronic Commerce, Electronic Government, Teleworking and Virtual Organization.

Hence the proceedings of the conference cover four main domains.
- Collaboration: This part deals with all the various efforts aimed at improving "working-together mediated by technology". Goal is an effective and agreeable interaction that comes close to habitual and natural ways of communicating and cooperating: the results achieved will be convivial systems.
- Tools and Design Methods: Working-together in co-located or geographically dispersed groups needs particular technologies. In a similar way methods for analysis and design have to be developed that can cope with the characteristic situation of cooperative work.
- Teleworking and Virtual Organizations: They are different sides of the organizational goal to use telecooperation technology for redesigning work. Although such innovations can be regarded as advantageous per se, they may induce an amount of change to organizations and users yet far from being managed adequately: striking the balance is a delicate task.
- Electronic Commerce and Electronic Government: Both applications have become the main beneficiary of Telecooperation with progress prompted by the rampant spreading of the Web. And yet significant questions remain open. They have to be solved in order to achieve the same degree of reliability, security and entrustment by electronic means as it is guaranteed in the conventional ways of doing business.

Many people have worked hard to form the conference and to prepare Program and Proceedings. So notable acknowledgement is owed to the Chairs and Members of the Program Committee listed below. Special thanks have to go to the Organising Committee chaired by Maria Tóth and Walter Grafendorfer and to those persons who have been involved particulary in the preparation: Wolfgang Hawlik, Gabriela Küng, Lisi Maier-Gabriel and Eszter Zubovics.

Roland Traunmüller, coeditor
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managing their intellectual property and accessing the institutions knowledge potential. The extent where institutional memory is retained seems to be enormous; individuals, culture, organizational structures and transformations, internal information repositories, and external archives.
- Telecooperation: Telecooperation is the most recent paradigm and the focus lies on cooperation in the broader sense. It is a pronounced holistic vision and it intends to integrate (at least to some extent) many paradigms mentioned above. Hence, Telecooperation comprises procedural and collaborative modes of work and is concerned with the managing of documents and the establishment of organizational memories for organizations.

It is the integrative perspective that enables Telecooperation to cover the whole fan of work activities within an enterprise. On one hand it will include common street-level-operations such as settling accounts in banking from home. On the other hand it means supporting "higher-level" organizational processes involving decision-making, negotiation, policy-formulation and planning. All these are marked by high complexity of issues, sophisticated procedural regulations, conflicting interests of stakeholders and the involvement of several persons.

It is the central role of work that makes Telecooperation such a remarkable paradigm. Not alone that work is put in the centre of consideration, it is also liberated from up to yet inherent spatial limits. Cooperation in unlimited space produces a global framework as important accomplishment. This effect is mirrored by a series of notions all illustrating extending space: Global Office, Telepresence, Teleadministration, etc. For the later one an illustration is given below.

Teleadministration, for instance, would imply remote access to administrative services and interaction from the home, from a kiosque, from a neighbourhood centre or from a public library. Regarding the topics of civic information systems they will comprise manifold services: general orientation, referral assistance, information about welfare, civic rights and duties, material on local affairs, consumer information, everyday information. Usage will range from quite simple questions (where-to-go) to the participation in planning processes.

A comment on the design of adequate solutions is to be added. Teleadministration should ensure comfort and sophistication of communication - notably by means of interactive multimedia. An appropriate solution has to include the use of intelligent software as well as the possibility to have - mediated by multimedia - a "quasi-face-to-face encounter" with a relevant officer. Bringing the pertinent expert into the dialogue may become necessary, because the case might include critical problems. Moreover, such mediated contact can solve issues of communication, interpretation and comprehension. Much to often such issues will occur considering the widespread experience that administrative language is not well understood by ordinary citizens.

Fast growth combined with swift commercialization are further characteristic traits of Telecooperation. The impressive growth is incited by sound progress in many fields; Collaboration, Tools, Methods, Mobile Computing, Web-technology, etc. It is a sometimes ebullient evolution leading to new products, new professions, innovative services and new lines of business. In someway, now, a degree of informatization of society is reached that already had been addressed twenty years ago in the prominent report of Nora and Mine.

There is an additional reason that this paradigm is so important. Telecooperation drastically changes the aspects of work for millions of peoples. It is a core question in all enterprises, how to do business now that this variety of technical means exists. This issue requires hard thinking about the ways in which work is carried out and shifts the interest from technical means to their adequate

Preface

Information is the lifeblood of modem society, its chief raw material and also its main product. So the world of business as well as the general public have much to gain from the increased use of information, from more sophisticated information systems, and from a creative and thorough redesign of existing information-handling processes. As the pace of change is growing in any field it is of paramount importance that the enabling potential of information technology is recognized to its full extent.

Telecooperation is an outstandig example for the power of enabling technologies. As well, it is the latest appearing manifestation of those guiding visions and paradigms that have governed application development. These visions and paradigms have come subsequently into the limelight of interest. Each of them opened new opportunities, but also maintained connection to earlier paradigms in order to incorporate existing capabilities as well. Some important paradigms are given in the following:

- Automation and Integration: Automating of decisions and integrating data into databases are examples of early guidelines of development. They governed the application development of the mainframe decade and have kept on to be significant.
- Document Management: This concept gained vigour from the fact that in office and administration documents are ubiquitous: recording policies, standards, and procedures; documenting contracts and agreements; presenting views of reality in reports and plans; creating images and impressions; providing mechanisms for communication; acting as vehicle for business processes; giving help for capturing and articulating concepts and ideas.
- Business Processes: Changing to a dynamic perspective means shifting the focus from documents to processes. Basic metaphor for this paradigm is the production chain derived from industrial engineering: each activity is intrinsically related to preceding and succeeding ones, so as to make synchronization a major issue. This Tayloristic model is suitable to the well structured office procedures and is supported by Workflow Management Systems.
- Collaboration: Oddly enough, it was the widespread usage of Workflow Management Systems that revealed their intrinsic limitations. It was realized that coordinated activities are not "the only game in office" and collaboration has to be supported as well. This has lead to the development of Groupware Systems with the round table as metaphor. As a pure type, Collaboration designates persons working together without any external previous coordination. It means working together as a group, understanding the intentions and activities of other members, and sharing information. Especially, for the higher echelons of management Collaboration is the prevalent mode of work.
- Management Information: Aim is exploiting the vast volume of stored data in order to get information for planning and decisions. Even the basic event of retrieval can become rather complex needing indexing, categorizing, semantic correspondences, definition of hyper-structures, fuzzy retrieval, case based search etc. A coimection with collaborative activities are Group Decision Support Systems (GDSS). They are aimed at the specific situation of taking collective decisions as a group. Many collective decisions are the result of a complex procedure and provide many starting points for assistance. GDSS are a good example that Management Information often is associated with other paradigms. Such associations might in some way explain the chamaeleonesque character of the paradigm Management Information. Concepts and labels have changed quite often and one could mention as examples such established concepts as EIS, DSS, KB-DSS, GDSS or recent approaches such as Data Mining.
- Organizational Memories: Building up memories for organizations is an old dream that has gained actuality. Enterprises and agencies invest more and more in the establishment and maintenance of

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MAIN CONCEPTS FOR COOPERATIVE WORK PLACE ANALYSIS[1]

Selmin Nurcan[2]

Abstract

Computer Supported Cooperative Work (CSCW) studies the possibilities and effects of technological support for agents involved in cooperative work processes. Many technologies dedicated to cooperative work environments such us cooperative requirements engineering or cooperative information systems have emerged in the past decade. For many organisations, structured and unstructured cooperative activities coexist in work processes and must be managed in the final solution. It is necessary to emphasise the specificities of these processes in order to take them into account as soon as possible during design. This work presents a model which is a synthesis of the concepts we believe essential for cooperative work place analysis.

1. Introduction

The growth of connectivity greatly expands opportunities for office workers to cooperate and work together. The fast development of the information and communication technologies (allowing better, faster and cheaper treatment of the information) acts as a catalyst for all kinds of computer supported cooperative work (CSCW) systems. In the cooperative work area, the past decade has witnessed the emergence of many technologies. In addition to electronic mail and server technologies, two others have emerged in this area: groupware and workflow.

According to C.A. Ellis, groupware is a "*computer-based system that supports groups of people engaged in a common task (or goal) and that provide an interface to a shared environment*" [5]. A well-known categorisation is the division into synchronous or asynchronous activity and co-located or distributed activity [10], *(figure 1)*. Workflow can be classified in the distributed asynchronous area of this matrix as electronic mail systems. This can be useful in quickly categorising, but it has limitations. According to J. Grudin, "*An e-mail system supporting discrete point-to-point communication is very different in nature from a work management system designed to support a large project over a period of years*". In his 3x3 matrix [7], Grudin

[1] This work is partially supported by the European ESPRIT long term research project, N° 21.903, CREWS (Cooperative Requirements Engineering With Scenarios).

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differentiates between activity that occurs at different and predictable times and places, and at different and unpredictable times and places *(figure 2)*,

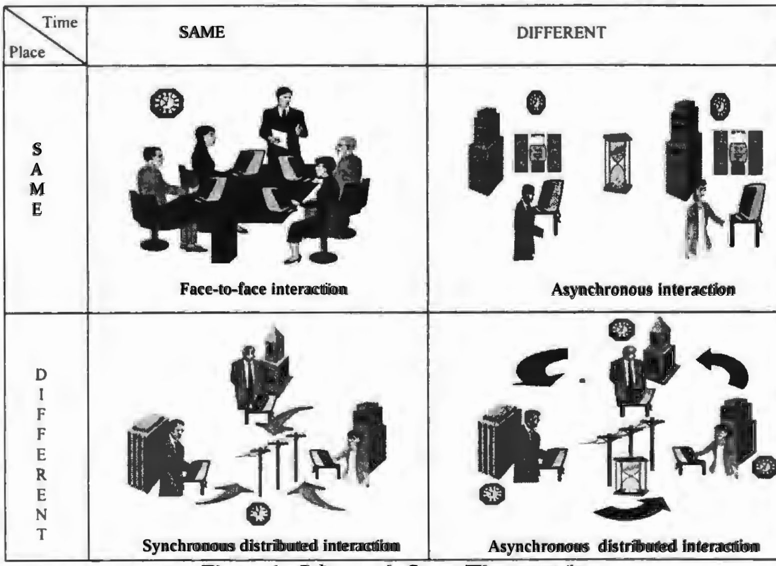

Figure 1 - Johansen's Space/Time matrix

		TIME		
		same	*different/predictable*	*different/unpredictable*
PLACE	*same*	meeting facilitation	work shifts	team rooms
	different/predictable	desktop conferencing	electronic mail	collaborative writing
	different/unpredictable	broadcast seminars	computer conferences	work management

Figure 2 - Grudin's 3x3 map of groupware options

Workflow applications focus first on the control of the information flow between various objects in the office with respect to a predefined procedure. The objects could be office workers, database servers, application files, etc. [11]. Workflow products allow the office worker to construct a diagram by linking nodes representing the office objects involved in the workflow. The links, between nodes of a workflow, control the flow of the information. In other words, workflow concerns, at first, an activity of scheduling and coordination of work between actors implicated in cooperative work processes. In a workflow application, cooperative work means that several persons are involved in reaching a common goal, but each of them acts individually in a different step (task) of the work.

CSCW applications have been divided into two different categories depending on the nature of the processes they support [22]. The first category concerns well-structured and repetitive work having important coordination and automation needs [15], [18]. This is the case for most of the office procedures. The second category of CSCW applications deals with occasional and ill-structured (ad-hoc) processes in organisations for instance, problem solving activities. The essential preoccupation with this kind of application is the information and knowledge-sharing in the work group more than the coordination of their tasks. Nevertheless, well-structured and ill-structured work processes often coexist in organisations *(figure 3)* and must be managed in the final solution [16], [17]. The integration aims to make transparent the transition between different types of group activities. This requires homogeneity and coherence of handled concepts. Frequently, users ask for adaptive workflow tools and models which can provide the robustness and the security of the predefined procedures and the flexibility of ad-hoc applications.

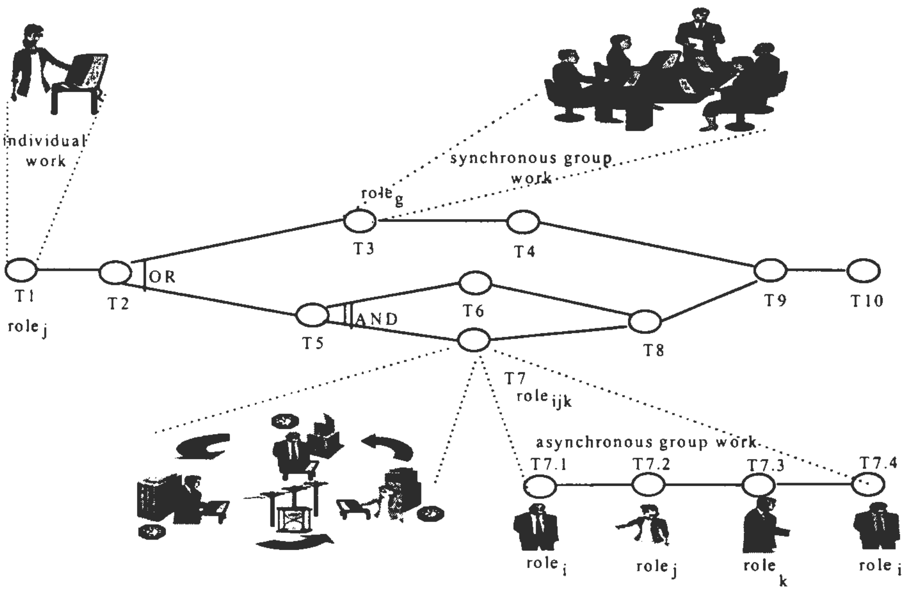

Figure 3 - An asynchronous cooperative process (workflow) coordinating individual and cooperative works

As information technology is becoming an integral aspect of organisations, more stakeholders with less formal training must be involved in requirements elicitation, validation and usage over long periods of time in a traceable manner. Effective and efficient team interaction become even more critical because systems must be continuously adapted to changing business practice and needs. Involving users and customers during the development of a requirements specification is a generally accepted goal. Requirements specification abstractly describe a future real world which stakeholders and requirement engineers have agreed on. Requirements engineering process is a cooperative process in which stakeholders and requirement engineers have to understand each other when eliciting and understanding requirements and reconciling differences at technical and social level. This is explored in the CREWS project [24] which will develop, evaluate and demonstrate the applicability of methods and tools for cooperative scenario-based requirements elicitation and validation [21], [23].

Our purpose is to provide a single set of the main concepts for analysing cooperative work processes. In order to take into account the specificities of cooperative work, we have considered models dealing with flow of task, role, and/or intention representations. This paper proposes a synthesis of the models we have studied. It is organised as follows. In the second part, we describe how cooperative work technologies imposes adaptation and often radical changes in the habits and processes of organisations. In the third part, we present briefly the models dealing with cooperative work representations we studied. This study shows a convergence on a set of concepts such as goal, procedure, task, role, actor, resource, decomposition of tasks, etc. However an appropriate model for cooperative work should also provide means to represent unstructured collective activities. In the fourth part, we propose our synthesis for these models, with the concepts which are essential from our point of view for cooperative work analysis.

2. Project oriented structures leading to horizontal organisations

Individual activities become integrated into group work, involving collaboration, cooperation, coordination and communication. Groups can carry out tasks which are not feasible individually. An organisation is a set of work processes and work groups which coordinate their activities, cooperate and negotiate with other people. The effectiveness of the organisation depends on the efficiency of groups which constitute it. The efficiency of the group depends on the cooperation between its members and decisions produced by them.

The aim of groupware is to support people working together. Workflow and other groupware systems can provide to the company the necessary competitive advantages to maintain or to improve its position in the market by responding better and faster to customers. Nevertheless, the automation of processes which have been structured without any consideration of CSCW technologies could not allow to organisations to reach long-dated objectives. Therefore, the organisation itself must be first improved or reengineered according the information technologies.

Until the middle of seventies, company organisation was strongly production-oriented. They were producing a lot while using few qualified manpower thanks to the fragmentation of tasks. This is the principle of scientific management founded by Frederik W. Taylor. The resulting organisation leads to a vertical division of work based on functional structures in an hierarchical structure which is sometimes very complicated. Today, the aim is not to produce but to produce efficiently in order to support selling. The increase in production capacity should not serve to increase the stock. The production process called "Just in Time Business" requires organisations which can speed up decision making thanks to minimal hierarchical structures. This is the principle of horizontal company with project teams built on processes in contradiction to the vertical company built on functions. The process is a set of activities which produces (from one or several inputs) an output valuable for the customer [9]. This approach which consists of a complete remodelling of the organisation around its processes is called "Business Process Reengineering" by Michael Hammer and James Champy [8], [9], An horizontal organisation emphasises the communication and the capacity to immediately react to market changes. The essential preoccupation is to increase customer satisfaction. Business Process Reengineering (BPR) is completely dependent on the development of information technologies. BPR consists of analysing and designing work processes in order to make them suitable to customers' needs. Information technologies are more than technical means to implement cooperative work processes, but processes change depending on the development of these technologies. The improvement or reengineering of work processes consists first of highlighting activities which comply with customer requirements. For the sake of improving or reengineering business processes Hammer and Champy consider essential to start to describe them as accurately as possible.

3. Models dealing with cooperative work

Workflow application development starts with the modelling of the work process to automate. In order to obtain a generic model for cooperative work processes, we have considered 8 models dealing with flow of task, role and/or intention representations.

3.1. Workflow models

Each workflow product proposes its own model to graphically represent procedures. Models are numerous but there are a few theoretical studies on which they are founded. Two types distinguish themselves: a) models coming from Petri nets (for instance, ICN), b) models coming from the Speech Act Theory (for instance, ActionWorkflow).

The ICN model (Information Control Net) was developed in the Palo Alto Research Center in the seventies [4]. An information control net is a set of procedures, steps, activities, roles, and actors with a valid set of relations between these entities. Relations include the *precedence* relation between steps; the *part-of* relation between activities and procedures; the *executor of* relation between activities and roles; and the *player of* relation between roles and actors. A procedure is a set of activities linked by precedence relationship. The ICN model allows the choice of the abstraction level in the representation and the building of a complex procedure by successive refinements. Alternative, parallelism and loop structures are used to describe procedures. The extended ICN model presented in [6] incorporates the notions of goal and unstructured activity.

In the Inconcert workflow model [13] a *job* represents a collaborative activity. A job consists of *tasks*, each of which is a unit of work that can be performed by one person. Tasks can be decomposed into sub-tasks, to obtain a hierarchical breakdown structure. Tasks at the same level may have ordering dependencies defined among them: a dependent task cannot be worked on until the precedent task has been completed.

VPL [25] is a graphical language to support a model for collaborative work processes. According to this model, work is decomposed into a network of requests for task assignments, which may be recursively decomposed to finer grained tasks. The *process* is modelled as requests for tasks. *Stages* represent the communications needed to coordinate tasks. Each stage represents a task request, commitment or question as a specific step in the process. A stage is a request from one person (the plan owner) to another person. The request may be expressed in any amount of detail; it is not constrained to a set of predefined tasks. This represents the Regatta philosophy of supporting communications without restriction.

The ActionWorkflow [14] comes from Winograd's and Flores' research aiming to study group work in relation to conversation, negotiation and decision making activities. Some conclusions of Speech Act Theory [26] have been used. The model uses a simple structure: it considers a task as a communication relationship between two participants, a *customer* and a *performer*. A task is represented as a loop composed of four phases: preparation, negotiation, performance and acceptance. The process model is built by successive refinements.

All these models have some common characteristics. They use a top-down approach which enables the choice of the abstraction level of the representation and the modelling of a complex process by successive refinements. They have the same finality: to divide a work process into a finite number of stages and to describe their flow.

3.2. Process modelling

The I* framework [27] has been developed to help supporting process modelling and reengineering. Processes are taken to involve social actors who depend on each other for *goals* to be achieved, *tasks* to be performed, and *resources* to be furnished. The framework includes a Strategic Dependency model and a Strategic Rationale model. According to I*, a business proeess would typically appear as a chain of dependency relationships, rather than as a sequence of input-output flows. A Strategic Dependency model is an intentional model and allows a richer representation of an organisation than conventional workflow models that are based on non-intentional entity and activity relationships. It describes the network of relationships among *actors*. The Strategic Rationale model describes and supports the reasoning that each actor has about its relationships with other actors. It shows "how" an actor meets its incoming dependencies or internal goals and desires by modelling actor's "ways of doing things" which are called *tasks*. A task is broken down into its components. Components are broken into sub-components, and so forth. The Strategic Rationale model recognises the presence of freedom and choice at each level of decomposition.

In [19] and [20], a meta-model is proposed as a basis for cooperative process model definition. Since a process meta-model carries information about the process model, an instantiation of it shall result in a process model. The meta-model can support different levels of granularity in decision making as well as non determinism in process performance. It identifies a decision in context as the basic building block of ways-of-working and permits their grouping into meaningful modules. Parallelism of decisions and ordering constraints are also supported. The cooperative process meta-model provides means to deal with secure and rather well-structured work processes and provides the flexibility to handle ill-structured cooperative processes. It allows us to represent cooperative work processes; to integrate conversations between agents; to guide and keep track of what happened in cooperative brainstorming sessions; to model the emergence of new contexts; all these being made in an homogeneous manner. The cooperative process meta-model allows us to deal with many different situations in a flexible, decision-oriented manner.

The OSSAD method (Office Support System Analysis and Design) [2], [3] has been developed within the context of an ESPRIT project whose aim was to find appropriate methods for the development of office automation systems. OSSAD is primarily concerned with the organisational functioning. It's aim is to conduct changes in the office, taking advantages of reorganisation opportunity offered by new technology. Computer science and office automation are considered as tools which assist the individual task. OSSAD proposes two levels of modelling: the abstract and the descriptive ones. The abstract level aims to represent the organisation from the point of view of its objectives disregarding currently-used resources. The descriptive level aims to represent current or future realisation conditions in accordance with objectives expressed in the abstract level. It takes into account organisational (organisation choices, responsibility sharing, information flow), human (arrangement of workers in different departments) and technical (tools) means.

[12] represents three different view of the Enterprise meta-model [1]. The first viewpoint describes the goal of the various stakeholders. The concept of goal is central to the teleological view. Goals denote intention. The social viewpoint describes the organisational members and how they interact. The process view includes the functional and behavioural viewpoints. It shows what process elements are being performed, and what flows of resources (data, product, etc.) are relevant to these process elements.

4. Main concepts for analysing cooperative work

As a synthesis of the studied models, we propose the model illustrated in *figure 4*. This model is represented using some binary ER-like notations. A large box represents an entity-type and a small box represents a binary relationship between two entity-types. The arrow head indicates the direction in which the label of the relationship holds. For example *(figure 4)*, *process* and *role* are entity types and are related through *responsible for* relationship. The direction of the relationship and the cardinalities mean, *a role can be responsible for one or several processes*. The model also includes the notion of an *objectified relationship.* This notion is an abstraction mechanism which allows a relationship to be viewed, at a higher level of abstraction, as an entity-type. This applies for example, to the relationship *dependency* between a *process* and another *process* which is viewed as the entity-type *dependency* to enable it to enter into a relationship with the entity-type *resource*. Finally, an arrow between entity-types represents the *is_a* relationship.

4.1. The concept of role

The concept of *role* is common to all the presented models. Our understanding about it is the following: a role is the definition of an organisational intention shared by a collection of users, all of whom have the same privileges and obligations to a set of work processes in an organisation.

According to *ICN* [6], a *role* may be associated with a group of *actors*. Also, one actor may play many roles within an organisation. An actor is a person, program, or an entity that can fulfil roles to execute, to be responsible for, or to be associated in some way with activities and procedures. In the *Inconcert* workflow model [13], a *role* is a logical placeholder for the *user* (person or program) that will perform a task. In *WPL* [25], a *role* is a container for list of names of people or groups. A role is not a quality of individual, but rather a relationship between a person (group) and a particular shared collaboration space (colloquy). A given person may play several roles in one colloquy while playing different roles in another colloquy.

The *I* Strategic Dependency* model [27] is a graph where each node represents an *actor*, and each link between two actors indicates that one actor depends on the other for something in order that the former may attain some goal. The concept of actor is specialised into *roles*, *positions* and *agents*. A role is an abstract actor. Physical agents such as human beings or software agents play roles. A position is a collection of roles that are typically played by a single agent. Agents occupy positions; a position covers a number of roles; roles are played by agents. The roles descriptive model of *OSSAD* [2] shows the current organisational structure chosen by the company (or the one which is proposed) to carry out its activities. It uses concepts of *role* and *unit*. A unit represents a set of roles assembled for the convenience of modelling. This can correspond to an administrative unit of the analysed organisation. According to *Enterprise models* [1], an *actor* is an organisational agent. An actor can be either an *individual agent* or a group (*organisational unit*). The individual concept denotes both persons, or machines, automated systems. Organisational units refer to organisational structures like departments, projects, teams, etc. Individuals and organisational units are related through the is-part-of relationship. A *role* corresponds to a set of process elements to be assigned to an agent as a unit of responsibility. Roles are assigned to actors depending on their goals and capabilities. The *cooperative process meta-model* presented in [20] attaches the notion of decision to a *role*. This captures knowledge about which decision can be taken by which role. Therefore, the basic division of responsibility in cooperative processes is imposed on the set of decisions of the meta-model. This allows to represent coordination of roles, to provide access control, and to give more appropriate guidance which is tailored to the role.

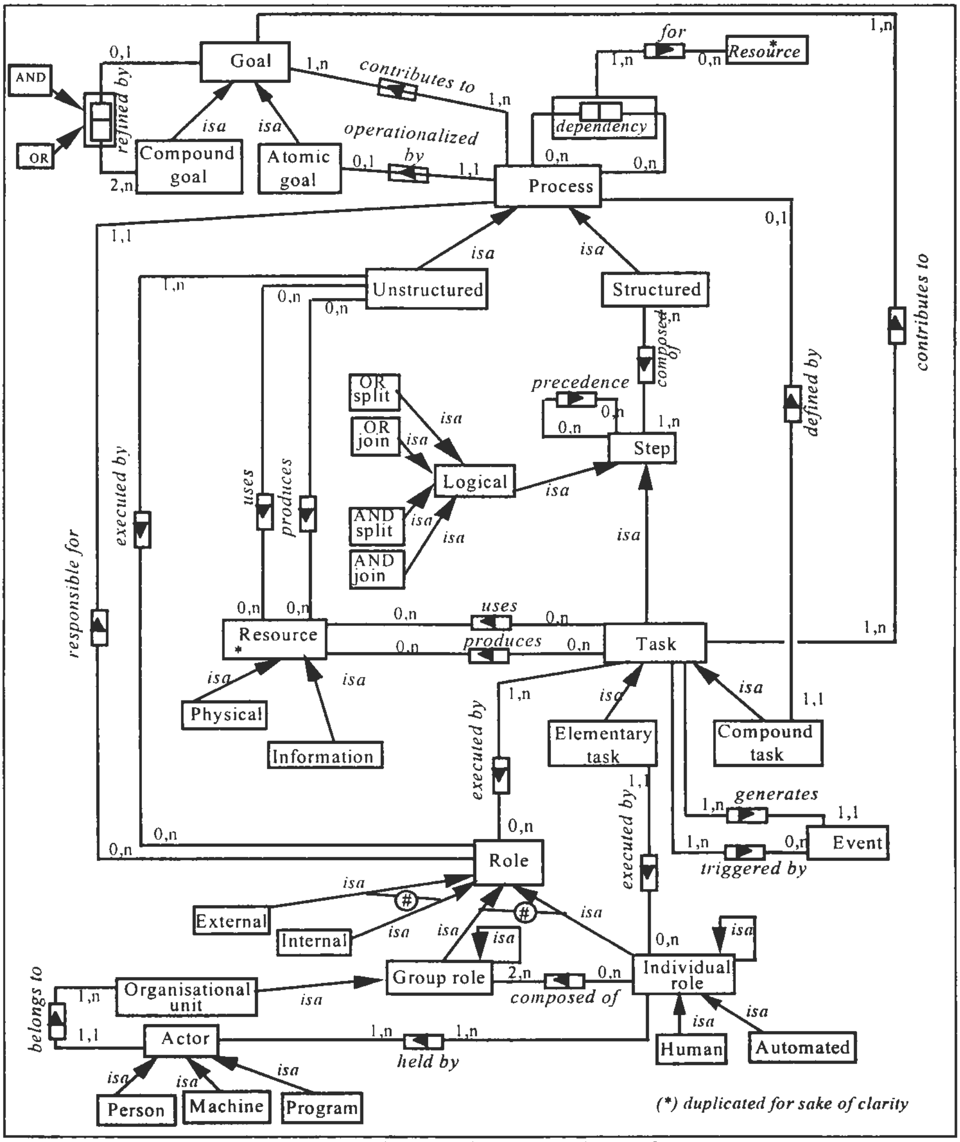

Figure 4 - A generic model for cooperative work processes

To our understanding, the *role* is the main concept for the representation of cooperative work processes *(figure 4)*. We introduce it in our model and then specialise it according to the following point of views. First, a *role* may be *external* or *internal* to the organisation. In the same time, it can describe an individual or a group. For example, the reservation clerk is an *individual role* whereas public relations team is a *group role.* A group role *is composed of* several individual roles. An *individual role* is specialised as *human* and *automated.* It is held by an *actor* which can be a *person*, a *machine* or a *program.* An *actor belongs* to an *organisational unit* which is a *group role*.

4.2. The concept of goal

Five of the presented models introduce the notion of *goal* even if this is made by the use of different labels.

Many social and organisational factors play an important role in the working of any organisation. Consequently, a useful cooperative work model must capture much more than the steps of procedures. The *ICN model* [6] advocates to choose people and *goals* as the starting point for organisation analysis, instead of choosing procedures and activities. It defines an organisational framework as a tuple *F=[G, H, R]* where G is a set of *goals*, H is a set of *actors*, and R is a set of *resources*. The *VPL model* [25] provides a shared collaboration space called colloquy, in which a set of tasks that are performed to accomplish the specified *goal* are coordinated.

The abstract model of OSSAD [2] defines stable and durable characteristics of the analysed system that any organisation choice must respect. It is based on the division of the organisation into *functions*, i.e. into sub-systems having coherent *objectives*. Each function may be divided into sub-functions, each in turn being sub-divisible: this is the "zoom" principle. At the most detailed level of the analysis, atomic functions are called *activities*. An activity has only one objective and has the semantics of the goal concept involved in ICN, VPL, I* and Enterprise modelling. These sub-systems communicate with each other and with the environment exchanging information packages (disregarding their physical support). According to the *goal dependency* notion of *I** [27], an actor (depender) depends on another (dependee) to bring about a condition in the world. The *goal* is an assertion that the dependee will make true. The dependee is free to choose "how" to accomplish the goal. According to the *Enterprise model* [1], *goals* denote intention and express the solution to some problem (problem-solving goals), or address some general vision or wish (wish-fulfilling goals), or satisfying some constraint (constraint-handling goal). The central concept of the *process meta-model* [20] is the one of *context* which associates a situation with an *intention*. A situation is a part of the product it makes sense to take a decision on. An *intention* expresses what the user wants to achieve, the goal. It reflects a choice that a user can make at a given moment in the process.

In our synthesis model *(figure 4)*, the concept of *goal* expresses an intention, this is what must be achieved. Goals are high level objectives of the organisation. They defines stable characteristics of the business that any organisation choice must respect. They can be compound or atomic. *Compound goals* can be decomposed into sub-goals. At the most detailed level, operationalisable goals are modelled using the *atomic goal* concept.

4.3. The concept of process

Operationalisable goals are implemented using *processes*, called respectively, procedure in OSSAD and ICN, job in InConcert, plan in VPL and process in Enterprise model.

According to [6], an extended information control net is a tuple, *S= [F, O, fg]* where F is an organisational framework (§ 4.2), O is a class of procedural objects (activities) and non-procedural objects (roles), and fg is a set of mappings over F and O. O and fg capture the procedural definition of ICN. Each *procedure* has *a responsible* person associated with it. A procedure can uphold several goals. In the *InConcert* [13] workflow model, a *job* represents a structured collaborative activity. In *VPL* [25], a process is modelled as requests for tasks in a *plan*. The person who is responsible for the result of the plan is the *owner* of the plan. The owner is usually the creator of the plan, and is the only person who may make changes in the plan.

In *OSSAD* [2], the link between abstract and descriptive levels is made by the activity/role matrix. Rows correspond to activities (abstract concept) and columns to roles (descriptive concept). For each activity, roles which are implied should be shown. Descriptive models deal with the organisational, human and technical means implemented to reach of the objectives of the organisation. They represent the way the work is done currently or will be done in the future. Each activity of the abstract level corresponds to a *procedure* in the descriptive level. The procedures descriptive model shows the functioning of the organisation, in other words, current or future work organisation. It uses *procedure* and *resource* concepts. This model provides a global view of relationships between procedures. According to *Enterprise models* [1], a *process* is a set of related steps carried out towards a common desired result. At an appropriate level of abstraction, a process performs some identifiable task in the enterprise. Processes use or produce/modify *resources* that can either be of physical nature (material), or information. Processes are triggered by *events* that correspond to specific state changes of the enterprise. The *process meta-model* presented in [20] can support different levels of granularity in decision making as well as non determinism in *process* performance. It identifies a decision in context as the basic building block of ways-of-working and permits their grouping into meaningful modules. Parallelism of decisions and ordering constraints are also supported. The meta-model allows to represent both well-structured and ill-structured cooperative processes.

With respect to the cooperative work model we propose *(figure 4)*, a *process* is the operationalisation *(operationalised by)* of one *atomic goal*. It *contributes* to the fulfilment of one or more goals. There is a role which is *responsible* for it. In order to show the functioning of the organisation, the model provides a global view of the relationships existing between procedures describing the *dependencies* for resources. Finally, a process can be *structured* or *unstructured*.

4.4. The concept of structured process

The essential preoccupation of *structured processes* is the coordination of their component work steps as in OSSAD, ICN, Inconcert and VPL.

In *ICN* [6], a *procedure* is a predefined set of work *steps* and a partial ordering of these steps. Partial ordering means that all steps do not necessarily need to be executed sequentially, and that loops are allowed. Steps can be related to each other by conjunctive logic or by disjunctive logic. According to *InConcert* [13], a *job* consists of tasks with *ordering* dependencies defined among them: a dependent task cannot be worked on until the precedent task has been completed. *Plans* are composed of network of stages in *VPL* [25]. Each stage represents a task request, commitment or question as a specific *step* in the process. When two or more *event* arrows are pointing to a stage it means that the first activated event from any one of them will activate the stage (except for the AND-node which has the property that it receives all expected events before it sends any event). While stages represent the major steps in a process, there are other kinds of nodes which provide some automated capabilities within the plan: programmed nodes, condition nodes, timer nodes, start nodes, exit nodes, AND-nodes.

The *OSSAD's operations descriptive model* [2] provides the detail corresponding to a *procedure*. It models the work distribution between roles showing who does what and in which order. This model uses a formalism similar to Petri nets. In addition to the order relationship between operations, this formalism shows tliree possibilities of *flow of operation*: parallelism (and), alternative (or) and loop.

We define a *structured process* as a predefined set of *steps* and a partial ordering of these steps. A step can be a *task* (§ 4.5) or a *logical step* (or-split, or-join, and-split, and-join). Logical steps define the control flow (task ordering) in structured processes. *Figure 5* shows the authorised *precedence* relationships between process steps. The *and-split* and the *and-join* allow to define parallel flows with rendezvous points *(figures 5-a and 5-b)*. The *or-split* and the *or-join* allow to define alternative flows *(figures 5-c and 5-d)*. A task can only be preceded and followed by one step, except the first *(figure 5-e)* and the last ones *(figure 5-f)*.

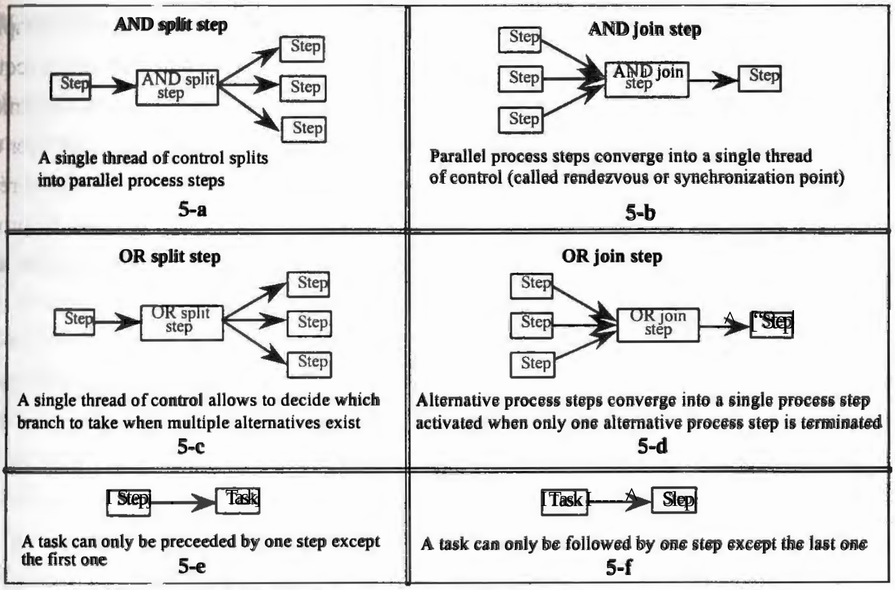

Figure 5 - Authorised precedence relationships between process steps

4.5. The concept of task

A *task* represents a work step in the process. It can be an *elementary task* or a *compound task defined by* another *process*. The notion of task decomposition has the semantics which is used in ICN (compound activity), VPL (compound stage), Inconcert (compound task) and OSSAD (vertical macro-operation).

In *ICN*, an *activity* is the body of a work step of a procedure. An activity is either a compound activity, containing another procedure, or an *elementary activity*. An elementary activity is a basic unit of work which must be a sequential set of primitive actions executed by a *single actor*. An elementary activity may also be a non-procedural entity whose internals ICN does not model within its structure. An activity is a reusable unit of work, so one activity may be the body of several work steps. In *Inconcert*, a *task* in a job is a unit of work that can be performed by one person having the assigned role. Each task in a job may also have any number of references, which are placeholders for *documents* needed in performing the task (for update or as reference material). Documents are abstract data objects which have content that can be manipulated by the appropriate application. This corresponds to the informational resources used in OSSAD and Enterprise modelling. Tasks can be decomposed into *sub-tasks*, to obtain a hierarchical breakdown structure. In *VPL*, a colloquy is composed of stages and roles. Each *stage* has an *assigned role* which is *responsible* for the stage. Stages represent the communications needed to coordinate tasks. A stage is a request from one person (the plan owner) to another person (the assignee). If the request is not to be completed manually, the assignee may create a *sub-plan* to accomplish the task. The assignee becomes the owner and creator of the new sub-plan and may make requests to others by creating stages within the sub-plan. The request may be expressed in any amount of detail; it is not constrained to a set of predefined tasks. A stage includes one or more user defined actions, called options. Each option represents a declaration that the assignee may take to represent the results of the task or decision. The act of choosing an option changes the state of the process. It does this by sending *events* to activate or terminate other stages. The event is an abstract mechanism that is used to coordinate stages.

In *OSSAD's operations descriptive model,* certain operations of a procedure may be gathered together to make macro-operations. The *vertical macro-operation* concept allows to describe operations performed by a given role in a higher level of abstraction.

In the generic model, an *elementary task* is defined as a sequential set of primitive actions executed by an *individual role* which can be *human* or *automated.* Tasks are *triggered* by *events* and their execution *generates* events. Tasks *use* and *produce resources* that can either be of *physical* or *information.* Tasks *contribute* to goals.

4.6. The concept of unstructured process

Nevertheless, organisations can not only be described in terms of structured work processes. In ICN, functional abstraction allows any activity to itself be defined as a procedure or a goal. If an activity is a goal, then there may be multiple procedures which can be invoked to attain the goal. The *extended ICN model* presented in [6] recognises that an organisation comprises resources and goals. This model incorporates the notion of *unstructured activity.* Thanks to the *horizontal macro-operation* concept, *OSSAD* also offers the possibility of highlighting the work steps which must be performed by *several roles* (cooperation). Actors can perform operations without simultaneous presence or using a synchronous communication. For *unstructured cooperative activities* which can not be represented in terms of flow of tasks, the horizontal macro-operation constitutes the most detailed modelling level that OSSAD allows us to obtain.

As advocated in ICN and I*, and briefly introduced in OSSAD by the use of the horizontal macro-operation concept, we adopted the specialisation of the process concept into two sub-types: *structured process* and *unstructured process.* An *unstructured process* cannot be represented in terms of flow of tasks. Then the generic model allows to represent it associated to a set of *resources* that it *uses* and *produces* and a set of participating *roles.* The key concept of unstructured processes is the information and knowledge sharing in the work group.

5. Conclusion

New information technologies allow to improve the quality of products and/or services produced by business processes. The use of CSCW systems has a direct influence on the work organisation. These systems make easier the definition of -more- horizontal organisations.

The analysis of cooperative work processes, with the intention of automating them using CSCW systems, require appropriate methods and models. The aim of cooperative work analysis is to understand the nature of the studied work processes and to find, in the case of well-structured processes, the relevant decomposition in tasks with their associated roles. Nevertheless, a cooperative work model should also provide appropriate concepts to represent more than work steps in processes. Indeed, social and organisational aspects, such as goal, role, resource, have an important role in the way of working of any organisation.

In the analysis of complex organisations whose work processes are not clearly defined, it is more relevant to study first goals of the organisation instead of its different functions. In this paper, we proposed a model as a synthesis of the 8 specific models we studied dealing with cooperative work representations. This model allows us to represent any cooperative process. Some of them are structured according to a partial order of work steps associated to roles and describe "how" the corresponding operationalisable goal could be fulfilled. Some others are unstructured and are described in terms of roles and resources which are involved and goals to whom the process contributes.

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Telecooperation Experience with the WinWin System

Alexander Egyed and Barry Boehm

Abstract

WinWin is a telecooperation system supporting the definition of software-based applications as negotiated stakeholder win conditions. Our experience in using WinWin in defining over 30 digital library applications, including several telecooperation systems, is that it is important to supplement negotiation support systems such as WinWin with such capabilities as prototyping, tradeoff analysis tools, email, and videoconferencing. We also found that WinWin's social orientation around considering other stakeholders' win conditions has enabled stakeholders to achieve high levels of shared vision and mutual trust. Our subsequent experience in implementing the specified digital library systems in a rapidly changing web-based milieu indicated that achieving these social conditions among system stakeholders was more important than achieving precise requirements specifications, due to the need for team adaptability to requirements change. Finally, we found that the WinWin approach provides an effective set of methods of integrating ethical considerations into practical system definition processes via Rawls' stakeholder negotiation-based Theory of Justice.

1. Introduction

By their very nature, telecooperation systems are people-intensive. Moreover, they project people into situations for which their social and ethical instincts are not well prepared: email ethics and etiquette; softcopy copyrights and licenses; privacy vs. freedom of information.

Given the increasing criticality of telecooperation systems, one would like to have system definition methods and tools which recognize the importance of social and ethical considerations, and integrate them within their system definition processes and frameworks.

However, with a few exceptions such as the European Participatory Design approach [11][18], most system development methodologies focus on information structures and dynamics. They generally consider social and ethical (and even economic) considerations as at best orthogonal to the job of specifying a system. More approaches are needed which integrate social, economic, and ethical considerations into the normal process of system definition.

The WinWin system discussed here [5] is an attempt to provide such a capability. It is both a telecooperation system and an approach to appropriately specifying telecooperation systems. Section 2 discusses the WinWin system components. Section 3 summarizes our experience with WinWin as a telecooperation system. Section 4 explains how its stakeholder win-win approach can integrate ethical considerations into system specification via Rawls' *Theory of Justice* [17]. Section 5 provides our conclusions.

2. WinWin System Components

2.1. Theory W

Theory W states that your project will succeed *if and only if you make winners of all the critical stakeholders* [4]. It includes a number of key principles and practices such as identifying critical stakeholders and their win conditions, system requirements as negotiated win conditions, expectations management, inventing options for mutual gain [11], and risk management of win-lose and lose-lose risks.

2.2. The WinWin Negotiation Model

The main purpose of a negotiation model [5] is to provide a stepwise approach for stakeholders to use in reconciling their individual win conditions.

The WinWin Model, as depicted in Figure 1, achieves this. The model contains four major artifact types – *Win Condition, Issue, Option,* and *Agreement* – and their interrelationships, as well as a *Domain Taxonomy*.

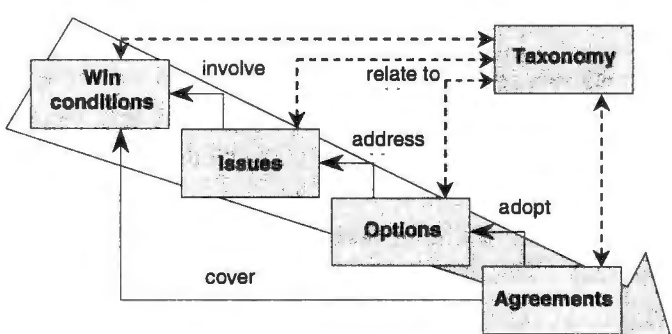


Figure 1: WinWin Artifact Relationships and Taxonomy

Win Conditions capture each stakeholder's goals and concerns with respect to the new system. If a Win Condition is non-controversial, it is covered by an Agreement. Otherwise, an Issue artifact is created to record the resulting conflict among Win Conditions (and stakeholders). Options allow stakeholders to suggest alternative solutions, which address Issues. Options are explored and refined via tradeoff analysis, expectations management, and negotiation, eventually leading to an Agreement to adopt an Option, which resolves the Issue.

The WinWin Model also includes a tailorable *Domain Taxonomy*, which enables stakeholders to link artifacts to taxonomy items and to access those artifacts via the taxonomy. In the WinWin approach the taxonomy structure follows closely the table of contents of requirements documents. Thus, the negotiators are able use the taxonomy as a checklist for ensuring sufficient coverage of the problem, and the resulting Agreements can be mapped straightforwardly into a requirements specification.

2.3. WinWin Spiral Model and the Iterative WinWin Model

The WinWin Spiral Model [6] is an extension to the ordinary spiral model [3] which answers the question of where the next level objectives, constraints, and alternatives come from. Thus, three activities were added upfront in order to incorporate the WinWin Negotiation Model into a more general development model (see Figure 2):

- Identify the system or subsystem's key stakeholders
- Identify the stakeholders' win conditions for the system or subsystem
- Negotiate win-win reconciliation of the stakeholders' win conditions.

Figure 2: WinWin Spiral Model [6]

We have observed in practice that these three initial steps do indeed yield the objectives, constraints, and alternatives needed for each cycle of the spiral. During each spiral cycle, the stakeholders concurrently and consistently refine the definitions of the problem (requirements) and its solution (design and plans). We have also defined a set of life cycle anchor points at which the consistency and feasibility of the problem and solution definitions are reviewed as the basis for management go/no-go decisions [6].

2.4. The WinWin Tool

The WinWin System [5][14] is a telecooperation tool that was built to support the WinWin negotiation model (see Figure 3). The tool uses Inter- and Intranet support to enable collaboration between distributed stakeholders. It may be used both synchronously and asynchronously, meaning that stakeholders may negotiate using the tool at the same time, but they may also use it at different times. Further, a number of support tools are integrated with WinWin to assist in the negotiation, especially in order to support tradeoff analyses, and to identify and resolve risks. The following are a few examples:

- A4 (Architecture Attribute Analysis Aid): Architecture-based analysis of cost, schedule, performance, and reliability.
- Rapidé: A architecture tool for modeling and simulating systems and identifying problems (deadlocks, bottlenecks, etc.) in the architecture.
- COCOMO (Constructive Cost Model) II: Cost/Schedule estimation tool [2].

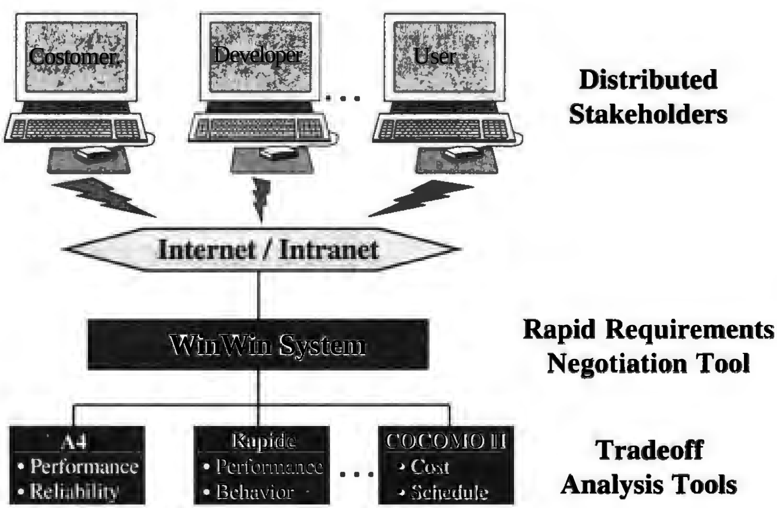


Figure 3: WinWin System Overview

A screen hardcopy of the WinWin tool is given in Figure 4. In the foreground a customer Win Condition of one of the Library projects is visible. To the right is the Taxonomy window and to the

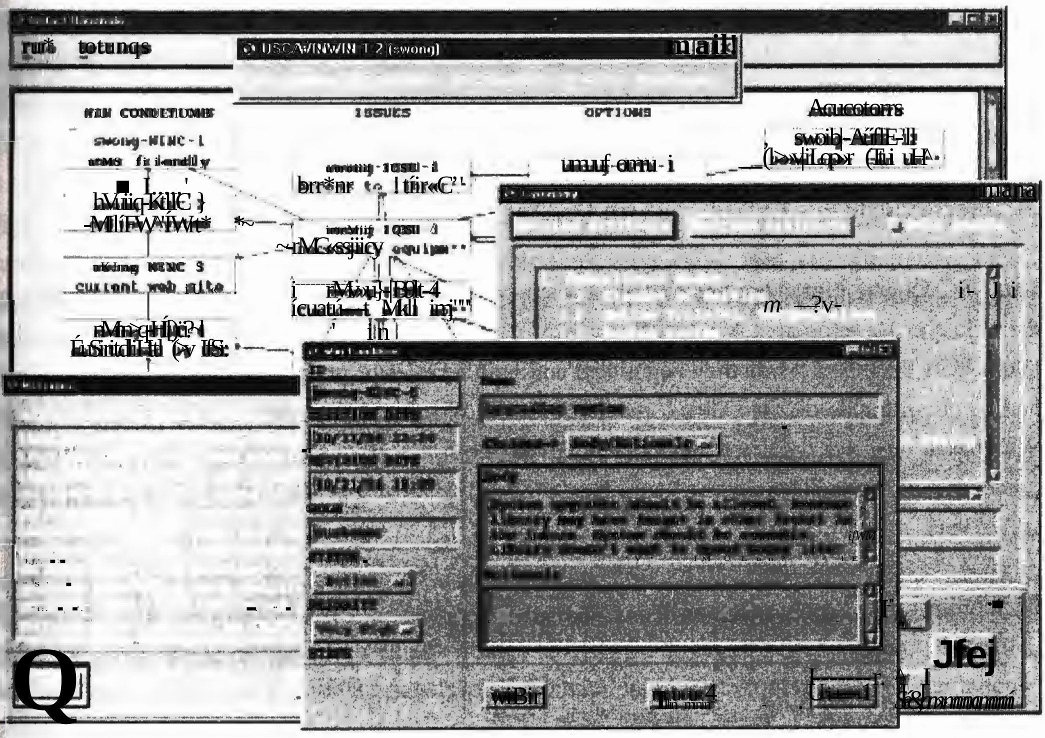


Figure 4: The WinWin Tool

Table 1: WinWin System Capabilities

Capability	**WinWin System**
Components	Win Conditions, Issues, Options, Agreements, Terms, Taxonomy Items
Connectors	Connections between Artifacts: • *Cover, Resolve, Adopt* (e.g. option resolves issue) • Simple *Relates To* showing some inter/intra artifact dependency • *Replace* (e.g. Agreement replaces an older one) Connections between Artifacts and Taxonomy Connections with external Tools (e.g. Analysis tools)
Views	Taxonomy view reflecting domain categorization Rationale view reflecting dependency and decision tree Message views reflecting the change history
Navigation	Hypertext Style browsing between Artifacts, Messages, and Taxonomy
Change History	Implicit through Artifact types Explicit through Messages describing nature and extend of changes
Information Sharing	Semi-automatic update (update only when requested by user)
Security	Artifact ownership; artifacts are frozen once voting is initiated
Completeness	Taxonomy (domain coverage) Artifact Flags
Group Control / Collaboration	Artifacts, Messages, and Comments Taxonomy, Terms, Rationale Graph, Status Summary External tools (Attachments)

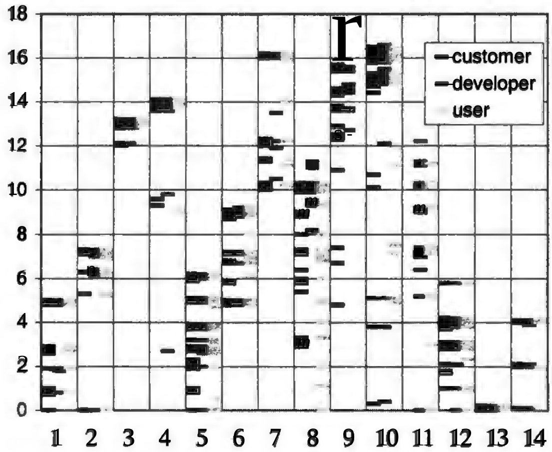
left the Message window. This window contains short descriptions of stakeholder changes in the order they were made. The background of the figure contains a graphical box-and-arrow diagram reflecting the current state of artifacts and their connections. Table 1 summarizes the tool's capabilities. More detailed information about the tool is given in [14].

3. Telecooperation Experience on Digital Library Projects

The USC Digital Library projects [7][8] constitute a major proof of the success and feasibility of the WinWin Development Model (Negotiation Model and Spiral Model). There 15 six-member teams were evaluated while they negotiated and built a series of multimedia related projects, which had to do with stereoscopic slides, medieval manuscripts, technical reports, planning documents, Web-based business data, and others. The developers were graduate students at the University of Southern California. The clients were librarians for USC's various discipline libraries and special collections.

Each project was conceived by a real customer from the USC Library and was derived out of a need in his or her community. Besides proposing the system, the library customers were also involved in negotiating the requirements with their student developer team(s), exercising prototypes, and reviewing project plans. The projects were planned and performed over a period of two semesters. All 15 teams produced satisfactory plans and specifications in the first semester. Six teams then delivered a real product with highly satisfactory initial capabilities (with one exception) at the end of the second semester.

Figure 5: Times people used WinWin (18 day period) by team number



Elaborate metrics were gathered about the negotiation, development process, people, and the deliverables. Results of those metrics were reported in a number of publications [7], [8], [10]. Some of the main results related to the telecooperation aspects of WinWin are shown in Figure 5 and Table 2.

Figure 5 shows the WinWin system usage patterns for each team, in terms of the times in which the customer, developer, and user stakeholder representatives were using WinWin. The teams with a mix of on-campus and off-campus students were Teams 1, 7, 9, 10, and 11. Their usage patterns tend to be more asynchronous than those of the on-campus teams.

Table 2 summarizes the results from the student critiques at the end of the semester. The strongest positive effects of using the WinWin approach were increasing cooperativeness, focusing participants on key issues, reducing friction, and facilitating distributed collaboration. The major improvements for the WinWin approach (now implemented) were increasing WinWin training, reducing usage overhead, and concurrent negotiation and prototyping. In addition, the Librarian critiques strongly indicated that the WinWin approach had increased mutual confidence and trust, and a willingness to participate in future projects.

Table 2: Student Critiques Summary

Positive Comments about WinWin	Count	Negative Comments about WinWin	Count
Should continue use of WinWin	9	Need more pre-WinWin homework	14
Promoted more cooperativeness and mutual understanding	9	Too much overhead in WinWin mechanics, bugs decreased negotiability	10
Focused team on key issues	8	Prototype concurrently w. WinWin conflict identification	10
Objective artifacts reduced friction, equalized loud and quiet participants	6	Should have direct Librarian involvement	6
Helped in distributed collaboration	5	Complement WinWin with email, whiteboards, video conferencing, etc.	5
Helped create better requirements	4		
Helped in understanding the requirements process	2	Need more time to do thoroughly	4
		UNIX platform limitations	2
Helped in adopting to changes	2	Need easier discussion support	2

In the Fall of 1997, 16 more teams successfully produced plans and specifications for additional Digital Library systems. Two of the teams represented more ambitious telecooperation experiments with respect to our campus and libraries in Los Angeles, one team being in San Diego and one team in Tucson, Arizona. For these teams, we supplemented WinWin and web-based project artifacts with videoconferenced Architecture Review Board meetings, including remote exercise of prototypes. After some startup difficulties, both teams were able to successfully collaborate with and satisfy their Library clients. Also some of the 1997 applications were telecooperation systems such as on-line network consultation support and semi-automated reference librarians. For these, the concurrent exercise of WinWin and prototyping were particularly important.

4. Integrating Ethics into Software Engineering Practice via WinWin

Some good software engineering ethical guidelines are provided in such publications as the *Software Engineering Code of Ethics* [13] and the *ACM Code of Ethics and Professional Conduct* [1], However, as mentioned above, such guidelines are not generally integrated into system definition methods and tools.

We have performed such an integration by linking the stakeholder win-win approach in WinWin with Rawls' *Theory of Justice* [17]. Rawls' theory is based on performing rational negotiation of issues by participants of society. It attempts to remove special-interest biases via a "veil of ignorance," in which participants address representative issue scenarios without knowledge of which participants may be most-favored or least-favored parties.

Collins et al. [9] have translated Rawls' theory of justice into the software domain, situating negotiations among a software system's *provider*, *buyer*, *user*, and a representative of public interest called the *software penumbra*. They provide a set of canonical ethical obligations of these stakeholders, and an example of negotiation considerations for a hospital information system, but do not identify methods or tools for supporting the negotiation process.

The WinWin approach and toolset does provide such support for integrating a Rawls-based ethics approach into the system definition process, by involving a stakeholder called an ombudsman, representing Collins et al.'s penumbra. We found it impractical to support the "veil of ignorance" in practical system definition negotiations, but otherwise found the approach workable.

An example of this integration occurred in applying the WinWin approach to the definition of an urban fire dispatching system. A win condition was entered indicating that dispatching decisions should be made primarily to minimize the loss of human life and health primarily, and secondarily to minimize the dollar loss due to property damage. An ombudsman stakeholder representing the general public entered an issue stating that basing dispatching decisions on dollar loss would discriminate against responding to fires in poor neighborhoods. The resulting agreement specified that minimizing dollar loss should be considered in responding to individual file incidents, but not in prioritizing across fire incidents.

Other ethical issues surfaced in the WinWin approach for the fire dispatching system included multilingual telephone operators, record keeping and accountability, and nominal vs. crisis performance priorities.

5. Conclusions

Our experience on over 30 projects using WinWin as a telecooperation system has indicated that its support for asynchronous negotiation and its task-oriented set of negotiation artifacts have made it an effective tool for rapid, distributed requirements negotiation. We found, however, that it is important to supplement negotiation support systems such as WinWin with such capabilities as prototyping, tradeoff analysis tools, email, and videoconferencing.

We also found that WinWin's social orientation around considering other stakeholders' win conditions has enabled stakeholders to achieve high levels of shared vision and mutual trust. Our subsequent experience in implementing the specified digital library systems in a rapidly changing web-based milieu indicated that achieving these social conditions among system stakeholders was more important than achieving precise requirements specifications, due to the need for team adaptability to requirements change.

Finally, we found that the WinWin approach provides an effective set of methods of integrating ethical considerations into practical system definition processes via Rawls' stakeholder negotiation-based Theory of Justice.

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MULTIPARTY COLLABORATION SYSTEM FOR NARROW BAND NETWORKS: BrowserMAJIC

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Abstract
This paper describes a multiparty collaboration system named "BrowserMAJIC" which is implemented on World Wide Web by Java Applet and works effectively even on narrow band networks. BrowserMAJIC uses still-pictures for showing the participants' portraits instead of movie-pictures and supports "pseudo gaze awareness" and "pseudo hand action". Since BrowserMAJIC does not need a high speed network, it may work smoothly in a telephone or wireless network environment.

1. Introduction

Face-to-face meetings are the best way to make decisions, but it is sometimes difficult to assemble participants at the same time and same place. There have been many studies on telecommunication support systems [1, 2, 3], and we think teleconferencing systems could be developed in two categories. One attaches importance to portability, in order to be able to communicate with anyone, anytime and anyplace. An example of this category is desktop conferencing systems [4, 5, 6]. We will be able to have meetings using multi-media notebook computers equipped with radio network facilities in the near future.

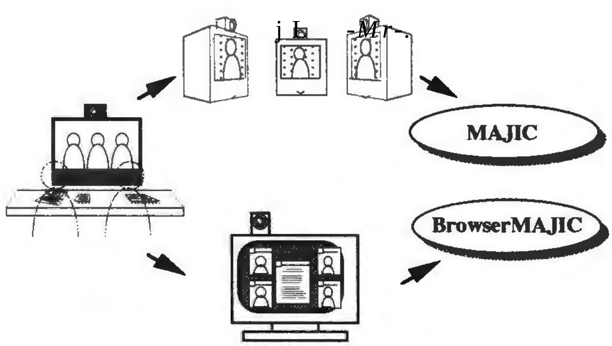

Figure 1. Two categories of Teleconferencing system.

The other category attaches importance to reality, and as a result, whose system usually requires a large space. In order to communicate by teleconferencing systems with a sense of presence, one of the most important problems is how to support eye contact among participants and provide life-size portraits of them. Many systems use a half transparent mirror to support eye contact, while other systems use a large screen to provide life-size portraits, but it is difficult to provide both. Moreover, in the case of multi-party teleconferencing, multiple eye contact and gaze awareness should be supported, and there should be no boundaries between the pictures to support a sense of presence or feeling of togetherness.

In order to communicate in a sense of reality in video conferencing, we have developed "Multi-Attendant Joint Interface for Collaboration" (MAJIC), which works in a multi-site and multi-user environment [7, 8, 9]. It is estimated that 60 percent of conversation involves gaze and 30 percent involves mutual gaze [10]. Therefore, eye contact and gaze awareness should be supported in video-conferencing systems. With MAJIC, users can make eye contact with each participant and be aware of the direction of each participants gaze; that is, they can recognize who is looking at whom. MAJIC achieves eye contact without the half transparent mirror which is used in most existing systems to support eye contact, and as a result, it can provide a work space at the center of participants. Moreover, MAJIC projects life-size video movies of participants onto a large curved screen without boundaries between them, and consequently users feel as though they are attending a meeting together and sitting around a table with the other participants shown as figure 2.

Figure 2. MAJIC conferencing system.

Although MAJIC is very effective, it needs a high speed network and special facilities. BrowserMAJIC is implemented on a conventional computer workstation, and supports pseudo gaze awareness and pseudo hand action. We use still-pictures instead of movie-pictures to transmit each participant attention. Still-picture portraits of the user in 9 different gaze directions are sent to every BrowserMAJIC in advance, and an appropriate one is dynamically selected during the conference to reflect where the user is paying attention. We call this function "pseudo gaze awareness". Moreover, when the user speaks, two pictures, that is, opening mouth and closing mouth, are shown alternatively like an animation. Therefore, it's very easy to recognize who is speaking now.

The other participants' mouse cursors on the shared application window are joined to their portrait window, allowing each user to be intuitively aware of which cursor belongs to whom. Namely, a communication space and a shared work space are integrated seamlessly. The mouse cursor has 3 different shapes, that is, pointing hand figure, writing hand figure, and holding hand figure, which are changed alternatively by clicking a mouse button. We call these functions "pseudo hand action". Since BrowserMAJIC needs only 1.2kbps bandwidth per one portrait window, it may work smoothly even in a telephone or wireless network environment.

2, Design of BrowserMAJIC

When we hold a face-to-face meeting, we gather at the same time and same place. So, we have a shared work space, and moreover recognize who is speaking to whom and/or what other participants are doing without paying special attention. On the other hand, when we hold a remote meeting by a teleconferencing system, using video image is considered to be similar to face-to-face meeting [2, 6, 11]. But participants' face images taken by a small video camera set up on the display are shown on the small video window which used picture in picture technic. It may be effective and convenient when two remote people collaborate and/or communicate using a desktop conferencing system. But when the desktop conferencing system is used by more than three persons (multi party teleconferencing), there are some problems. All of other participants images are usually shown as facing downward, because each video camera is set up on the display which each participant is looking at. Therefore, user's faculty is limited in

(1) directing their gaze to each participant,
(2) establishing eye contact with other participants,
(3) being aware of who is visually attending to whom,
(4) listening to different parallel conversations selectively,
(5) making comments to other participants,
(6) holding parallel conversations, and
(7) making sure intuitively who is drawing on the shared work space.

Therefore, we identified the following four design requirements to implement BrowserMAJIC.

Portability

To collaborate at anytime and anyplace with anyone, it is required that a desktop conferencing system can be performed by any kinds of computer connected the internet. And special devices may not be set up on the different kinds of computer in the same way. Especially in case of using a note PC, it is difficult to set up special devices, if possible, this makes the portability lacked. Since we want to avoid using extra device possible, we use a mouse and a microphone which are standard devices of PCs.

Narrow band network

As we described in the previous section, many of desktop conferencing systems are using video image to show the partners' faces. But it causes heavy network traffic. And the user may not be able to communicate smoothly because of the delay of networks and the power of PC. Moreover, video camera has to be set up on the computer. And if possible, it should work on the telephone or Wireless networks, that is, narrow band network.Therefore, we selected to use still-pictures instead of movie-pictures to show the partners' faces.

Space integration

In the face-to-face meeting, people can see both partners and a shared work space. So, they can recognize who is doing what without special attention. A desktop conferencing system consists of a communication space for transmitting who is attending at the meeting and speaking now and a shared work space for transmitting what someone is doing. But there is no relationship between objects in the shared window and the owner or the handler of them in the portrait window. So, it is difficult to know who is doing what intuitively, because there is a seam between both spaces. Therefore, communication space and working space should be integrated.

Awareness support

In the case of meetings with more than three participants, it is important to know who is speaking to whom. If we can not recognize that, we may not be able to control the flow of the conversations. As a result, it is difficult to communicate with other participants smoothly. Therefore, the conferencing system should support the function which shows who is speaking to whom and/or who is spoken by whom.

3. Functions of BrowserMAJIC

3.1 Pseudo gaze awareness

When we communicate with other participants in a meeting, we usually become aware of their attention by the direction of their face and gaze. On the other hand, when we use a desktop conferencing system, recognizing what object the other participants are looking at may be important to communicate smoothly. But we need a special device like an eye tracker to trace eye movement. Moreover, user sees simply all of other participants images which are usually shown as facing downward by a conventional dasktop conferencing system.

Therefore, we use still-pictures instead of movie-pictures to transmit each participant attention. Still-picture portraits of users in nine difference gaze directions are sent to every BrowserMAJIC in advance, and an appropriate one is dynamically selected during the conference to reflect where the user is paying attention. The most difficult problem is how to recognize an object which user pays attention. Since we do not want to use special devices, we assume each participant is paying attention to wherever their mouse pointer is on the screen.

When a remote user moves his/her mouse cursor from one object to another one, the x-y coordinate of the mouse pointer is transmitted to the other client machines and his/her portrait changes to be looking in the direction of the object which he/she is pointing now. We call this function "pseudo gaze awareness". Moreover, when the user speaks, two pictures, that is, opening mouth and closing mouth, are shown alternatively like an animation (see Fig. 3). Therefore, it's very easy to recognize who is speaking now.

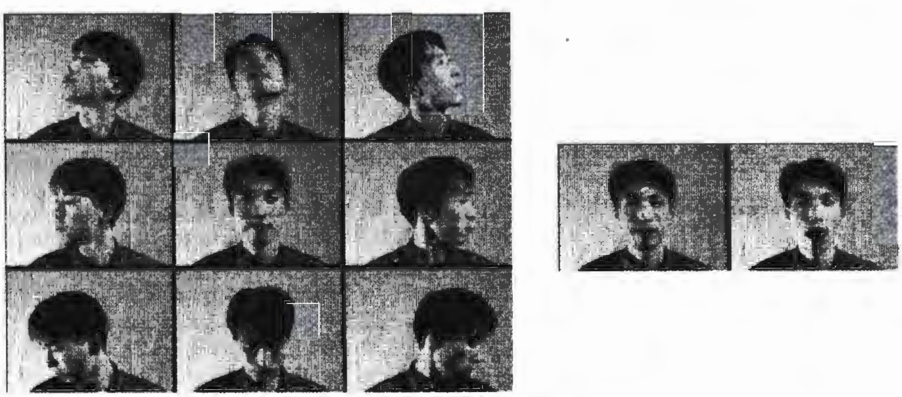

Figure 3. Still-picture portraits of the user in 9 different gaze directions.

3.2 Pseudo hand action

The other participants' mouse cursor on the shared work space is joined to their portrait window by drawing the line as if it is his/her arm, allowing each user to be intuitively aware of which cursor belongs to whom (see Fig. 4). Namely, a communication space and a shared work space are integrated seamlessly. The mouse cursor has three different shapes, that is, pointing hand figure, writing hand figure, and holding hand figure, which are changed alternatively by clicking a mouse button. We call these functions "pseudo hand action".

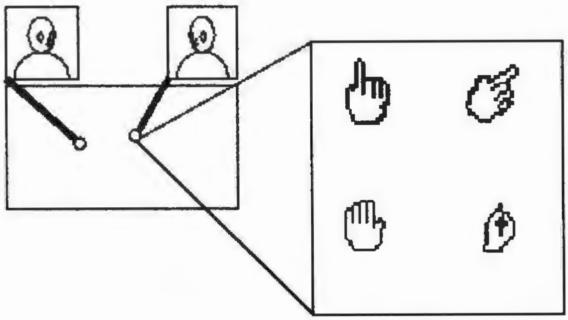

Figure 4. Pseudo hand action.

4. Implementation of BrowserMAJIC

BrowserMAJIC is a client/server system in which BrowserMAJIC clients are implemented as Java applet and a BrowserMAJIC server is implemented as Java application. The feature of the architecture of BrowserMAJIC is that it is not necessary to install executing files and/or libraries in client machines because all necessary files are stored in the World Wide Web server. All of user's need is a WWW browser applied to Java.

Before attending the conference, each user prepares his/her own eighteen still-pictures and stores them in the directory of his/her home page. To start a BrowserMAJIC client, users execute a WWW browser, e.g. Netscape Navigator, and input the URL in which the client Java applet stores. Then the Java applet is transferred and executed automatically. Fig. 5 illustrates the data flow of Browser-MAJIC at the first stage.

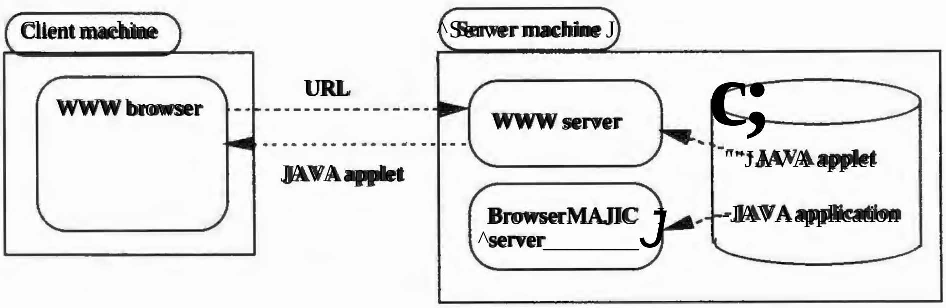

Figure 5. Data flow of starting BrowserMAJIC.

We provide four meeting rooms in our WWW server of the prototype system. After clicking the name of the meeting room which they want to attend, the client Java applet requests a user name and a URL in which his/her still-pictures is stored. When a user did not prepare his/her own still-pictures, he/she can use the default face pictures which the system prepared. When each user's URL is transmitted to the other clients mediated by the server, each client receives the other participants' face still-pictures through the WWW server. The WWW server is utilized for transmitting still-pictures, because it is easier than utilizing BrowserMAJIC server and the load average of BrowserMAJIC server is decreased. However some of WWW browser forbid transmitting still-pictures by utilizing WWW server because of security. In this case, user uses the file relay server.

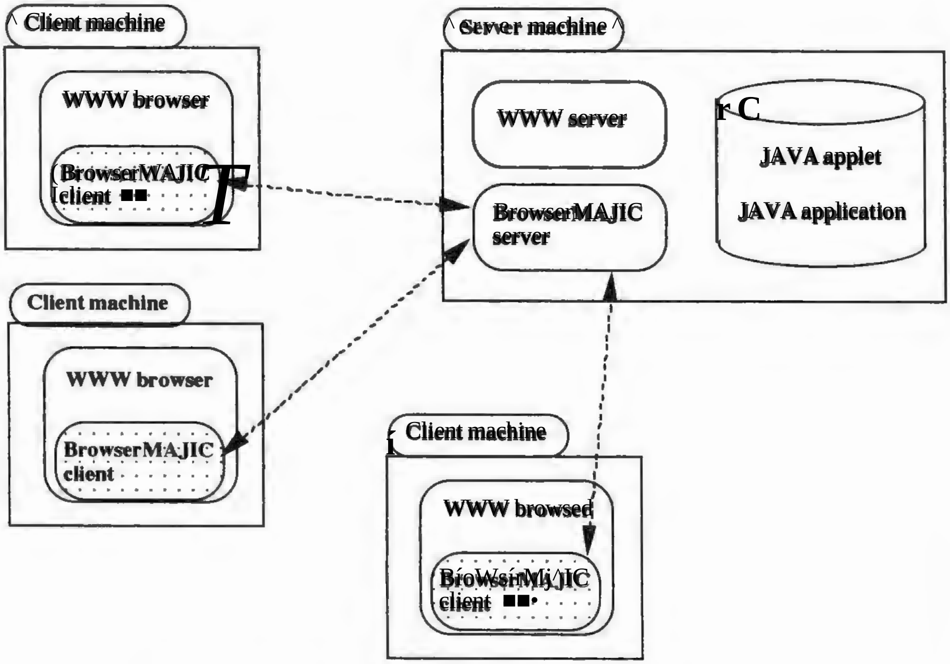

Figure 6. Data flow of BrowserMAJIC during the meeting.

Figure. 7 BrowserMAJIC in use.

The BrowserMAJIC Clients transmit users' face direction, voice and the position of mouse pointer mediated by the BrowseMAJIC server during the meeting (see Fig. 6). And when the server receives data from a BrowserMAJIC client, the server transmits it to all clients.

Fig.7 shows the screen copy of BrowserMAJIC in use. Four persons (the owner of this screen and three other participants) are attending at the meeting. The person in middle is pointing a drawing area (shared work space), and the persons in both side are gazing each other.

The URL which our system has been placed in is open to the public. There had been 700 access for about a month. And we investigated the system log. As a result, 39% of visitor could use BrowsrMAJIC, but 61% of them could not use it because their firewall interrupted data. In order to solve the firewall problem, BrowserMAJIC server should be placed inside of the firewall.

5. Conclusions

We have described the design and implementation of BrowserMAJIC which provides pseudo gaze awareness using some still-pictures and pseudo hand action. "Apple Quick Time Conference" as usual desktop conferencing system, which uses video image needs about 80kbps band width per one video window.On the other hand, BrowserMAJIC needs only 1.2 kbps bandwidth per one portrait window. It may work smoothly even in a telephone or wireless network environment.

It may be important to recognize intuitively who is speaking whom, what the other participants are doing, and to which they are paying attention at the meeting. Therefore, when we design a multi-party desktop conferencing system, we should consider how it supports this kinds of awareness. Since we do not want to use special devices for BrowserMAJIC, we assume each participant is paying attention to wherever their mouse pointer is on the screen. It might be unnatural assumption. We are investigating of user feedback on BrowserMAJIC to improve it.

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Co-presence and Co-working in a distributed office

Vali Lalioti and Thilo Horstmann

Abstract

Today's technology and advances in telecommunication rapidly change the way business is carried out, making it a globally distributed and thus a more electronically-based process. Support for interaction, coordination and group work in the emerging distributed businesses should be adapted accordingly, both in terms of the way it is carried out and in terms of the tools used. CSCW systems, video-conferencing and electronic meeting systems, facilitate the process of preparing and carrying out meetings, and at producing material via a group effort in a distributed business. However, the limitations of desktop video conferencing are clearly revealed when body language and eye contact become important. In this paper two systems, namely TELEPORT and BSCW, are integrated in order to provide support for co-presence and co-working. TELEPORT is a teleconferencing system that merges real and virtual environments, and by the use of wall display surfaces and viewer tracking provides the sensation of a face-to-face meeting for geographically dispersed groups [6]. The BSCW system, provides basic facilities for collaborative information sharing, activity awareness and integration of external applications for a variety of platforms over the World-Wide Web [2]. In the approach presented in this paper, the BSCW system is used for preparing and changing any material necessary for a TELEPORT session and most importantly for supporting the brainstorming, structuring and evaluation of ideas during the session, where real-time composition of live-video, synthetic backgrounds and electronic documents is then projected on the wall-sized display of TELEPORT.

1. INTRODUCTION

The worldwide nature of today's market has forced many companies to decentralize their organizational structures. Optimally tailored working environments are required for computer-supported cooperative work. One stream is to provide real-time collaboration tools to geographically dispersed teams in order to facilitate meeting support. Often the situation arises that a person working on a business process needs external help or expertise to fulfil the task. As of today the person will try to phone the expert or at best have a desktop conference with audio-visual connectivity plus the use of shared documents. Several desktop video conferencing systems have been described in the literature [1][5][7][21] and commercial products are available. In addition, a variety of groupware is used to support the increasingly complex and elaborate business processes of today's organizations [18][10][9].

In a distributed business there is an equal need for support for group work. However, the definition of a group or a meeting is somewhat broader than that of a non-distributed one. In particular, group members might be geographically separated, resulting a different-place same-time (synchronous), or different-place different-time (asynchronous) group working situations [13]. In local working groups, the lack of synchronous collaboration support in asynchronous CSCW systems, can be easily overcome by social interaction. However, this is not the case for widely dispersed working groups. Social interaction becomes more difficult and must be supported by appropriate collaboration facilities. Although desktop video-conferencing or electronic meeting systems address such situations, it is still recognized that there are many situations were face-to-face meetings are essential [19][20]. In situations, such as distributed negotiation, conflict resolution meetings or remote seminars and teaching, body-language and eye contact become important. Ideally, in such situations, we would like to provide geographically separated group members with a sensation of being in the same room at the same time and meeting face-to-face. This is what is called "co-presence".

A synchronous collaboration system that provides high degree of co-presence is TELEPORT [6], developed at the Visualization and Media Systems Design Group of GMD, by S. Gibbs, C. Breiteneder, and C. Arapis. TELEPORT integrates several key features, such as: a semi-real, semi-virtual meeting space, a wall-sized display supporting mono and stereoscopic viewing, viewer tracking and real-time rendering, compositing of video-textured surfaces within 3D geometric models. However, TELEPORT sessions are expensive and must be carefully prepared.

The preparation process might involve participants from different organizations and/or in different locations. In order to produce the session's agenda or other artifacts needed, we decided on using the BSCW Shared Workspace system [2][3][4]. BSCW (Basic Support for Cooperative Work) is a system developed by GMD.FIT, which provides support for cross-platform information sharing for groups of users over the World-Wide Web. During the co-presence session information in the form of electronic documents, presentation material and shared workspaces is displayed on a virtual projection wall which is blended together with video imagery from remote participants into the virtual extensions of the display rooms. The following sections give an overview of systems that provide similar functionality and then briefly present the two developed systems, namely TELEPORT and BSCW. Furthermore, our approach for co-presence and co-working is described in section 4 by the use of two examples, the distributed seminar and distributed meeting cases. Finally, section 5 concludes this paper.

2. RELATED WORK

Applications to support the collaborative work in working groups integrate information processing and communication activities. Following [16] we can roughly divide these applications depending on time and space categories (Table 1). So called Same Time/Different Places applications allow members of the working group to collaborate in dispersed locations at the same time, Different Times/ Different Places applications to collaborate in dispersed locations at a different time, etc.

	Same Time	Different Times
Same Place	Electronic Meeting Rooms Group Decision Support Systems	Shift work
Different Places	Video Conference Systems Chat Applications Audio (Telephony) Applications	Workflow Shared Calendars E-mail Shared Workspace Appl.

Table 1 CSCW Taxonomy

Current research in CSCW, however, suggests to overcome the boundaries between the different application areas [11][13]. Often a working group currently working in an electronic meeting room [18], need to access data maintained for example, by a shared group calendar tool. On the other hand, users of workflow system should have access to an audio application to get more information on an artifact from a colleague in a different room or department. In this paper we focus on the integration of Same Time/Different Places applications (namely Video Conference systems) with Different Times/Different Places Applications (namely Shared Workspace applications). In this section we collect existing synchronous collaborative applications mainly in the area of video conferencing and asynchronous applications that have been designed for use in the Internet.

2.1 Synchronous Collaborative Applications

A variety of synchronous systems and research prototypes exist using metaphors such as the blackboard, or the desk for creating a shared working environment that resembles a physical desk or a blackboard. *LiveBoard* has a 67-inch, full-color, rear-projected display controlled by a standard MS-Windows based PC[24]. Users can draw on the screen, run Windows applications, or see other people at remote sites.

ClearBoard[15] uses the metaphor of a transparent glass window. It provides eye-contact and a shared drawing space for remote collaboration between two users. *VideoWindow*[23] uses a very high aspect ratio (8:3) video display, allowing for the impression of talking to and seeing people in an adjacent room through a window using a large display device. *DigitalDesk*[22] provides a computer-augmented environment in which electronic images are projected onto a desk and onto paper documents. Interaction is done via pens or bare fingers and paper documents can be read into the system simply by placing them on the desk.

Currently there are also a number of commercial systems available. They are mainly built on top of low-bandwidth technology like ISDN or the Internet. The most prominent representatives are *ProShare* (Intel), *NetMeeting* (Microsoft) or *CUSeeMe* (WhitePine Software). They allow the transmission of low-resolution video frames along with a synchronized audio stream. As for the Internet based systems (NetMeeting, CUSeeMe) the quality depends on the bandwidth available. The ISDN-based systems (ProShare) allow for a better quality up to 20 frames/sec. ProShare and NetMeeting both support synchronous sharing of applications like MS-Word or other Windows applications with a limited support for floor control. However, scheduling and preparing a collaborative working session requires additional means like e-mail or telephone.

2.2 Asynchronous collaborative applications for the Internet

With the wide spread adoption of the World Wide Web (W3) a number of applications have emerged that use the W3 as the basis for information sharing across widely dispersed working groups. Numerous studies pointed out the potential of the Web as an enabling technology for developing cross-organizational groupware applications. The W3 addresses problems of integration, allowing developers to foeus on application details rather than complexities of different system configurations [2][5].

In this direction, Groupware systems have been developed to support for example decision making, or document/information sharing and structuring. AltaVista Forum is a structured storage and management area for office documents, accessible through the Internet with any standard browser [8], and allows team members in different locations to create document-sharing processes and discussion forums. WebEvent is a W3 group calendar program which allows users to access event (calendar) information in a simple format. The WebShare suite of products allows companies to create customized groupware applications for internal teams using the infrastructure of the W3 [25]. WebShare supports structured information sharing and management within an organization. HyperNews supports conferencing on the World-Wide Web [17]. HyperNews lets readers add responses to existing WWW pages. Furthermore, responses to each of those responses are displayed to an arbitrary depth.

3. BACKGROUND

3.1 Teleport

Co-presence in TELEPORT overcomes some of the major limitations of the current desktop video conferencing systems. TELEPORT mimics a shared physical context, and provides life-sized display of remote group members placed within a virtual space [6][12].

Figure 1 TELEPORT Display Room

Figure 2 Remote Participant in Virtual Meeting Area

The system is based around special rooms, called display rooms, where one wall is a "view port" into a virtual extension as shown in Figure 1. The geometry, surface characteristics, and lighting match the real room to which it is attached. When a teleconferencing connection is established, video imagery of the remote participant (or participants) is composited with the rendered view of the virtual extension (see Figure 2). The viewing position of the local participant is tracked, allowing imagery appearing on the wall display to be rendered from the participant's perspective. The result is a natural and immersive teleconferencing environment where real and virtual environments are merged without the need for head-mounted displays or other encumbering devices.

The current system uses a 3m x 2.25m rear-projected *video wall* attached to a 3m square room. The video-wall is driven by a pair of high luminosity video projectors. A *camera* is placed on a stand or a table and set at approximately eye height. A *viewer tracking system* determines the position of the local participant within the display room, from which their viewpoint is derived. Two techniques are used for *segmentation* (for determining the regions of the video signal where a participant appears) chroma-keying and delta-keying. Currently an SGI RealityEngine2 is used to achieve rendering rates, with texturing and full anti-alising of up to 25 frames per second. The video imagery of remote participants is combined with the rendered virtual extension *(compositing)*. For audio, each participant wears a small microphone. The audio signals from remote participants are mixed together, and sent to speakers mounted on either side of the video wall.

3.2 BSCW

The BSCW system is based on the notion of a 'shared workspace' which the members of a group establish for organizing and coordinating their work [2][3][4][14]. A shared workspace, as realized by BSCW, is a repository for shared information, aecessible to group members using a simple user name and password scheme. A BSCW server (a Web server extended with the BSCW system through the CGI programming interface) manages a number of such workspaces for different groups and users may be members of several workspaces (e.g. one workspace corresponding to each project a user is involved with).

A workspace can contain information such as documents, images, links to other Web pages or FTP sites, threaded discussions, member contact information and more. The contents of a workspace are represented as information *objects* arranged in a folder hierarchy. Members can transfer (upload) information from their machines to a workspace and set access rights to control the visibility of this information and the operations which can be performed by others. Members can download, modify and request more details on the information objects by clicking on HTML links to request workspace operations from the BSCW server. After each operation the server returns a new HTML page showing the new state of the workspace (Figure 3).

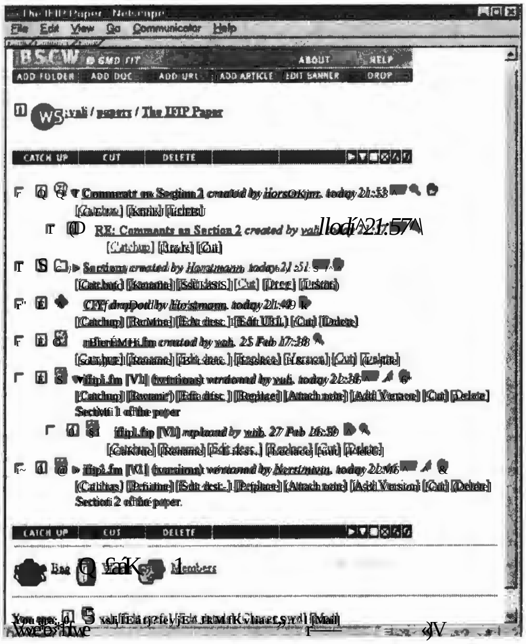

Figure 3 A BSCW Shared Workspace.

The event service provided by the BSCW system provides users with information on the activities of others with respect to objects in a workspace. Events are triggered when a user performs an action such as uploading a document, renaming a document and so on. The system presents the recent events to each user as event icons in the workspace listing (Figure 3). The system distinguishes several types of events in the workspace listing such as 'new', 'read', 'written' and so on. This service therefore provides a very simple form of event information regarding changes within the workspace.

4. The Co-presence and Co-working Approach

To overcome the limitations of desktop video conferencing and provide support for co-working, we integrate the functionality of the two systems. Our approach provides support for co-working before, during and after co-presence. In particular, preparation of a group meeting with participants from remote sites is supported by the use of the BSCW common workspaces. Group members can prepare agendas, schedules, shared documents and electronic material that might be necessary for the session. This is also the phase, where decisions such as who is participating in the meeting or which material should be prepared from each site are made. Once the preparation phase is completed, group members from different sites are now ready to meet in the purpose build display rooms in each site. Information in the form of electronic documents, presentation material and so on, are then displayed on a virtual projection wall and combined with the 3D virtual room and the remote participant's video image.

4.1 Seminar Example

To exemplify the approach, we first consider the remote seminar case. In today's distributed companies seminars and skill improvement courses could be very costly both in terms of time and money, because of the travelling involved. Also seminars very often are about or make use of specific software tools which require the use of a well prepared seminar room with the necessary hardware and software installed for this particular situation.

Figure 4 virtual projection wall within the virtual extension of a TELEPORT display room

In our approach the expert and students meet in a TELEPORT session and are able to view teaching material, ask questions and have a seminar that provides the illusion of been in a seminar room together with other participants and face to face with the expert. This is achieved by introducing a virtual projection wall that is mixed in the 3D model of the virtual rooms and can be directly connected, for example, to the expert's notebook. Thus the expert can choose what to show to the other participants, i.e. slides, pie charts or the way a software tool it's been used (Figure 4). The image from the expert's notebook is textured-mapped onto a virtual projection wall and combined with the virtual 3D room, rendered in real time and transferred to the other participants' display rooms. In addition, video imagery of the participants is also texture-mapped into a surface within the virtual rooms (Figure 5).

There are a number of advantages in this approach. Firstly, the participants can focus on the speakers and be able to glance at the operations performed by him/her on the virtual projection wall, thus the concentration of the participants does not shift from the expert to a computer screen or computer window as happens with most of the teleconferencing systems. Furthermore, the expert can t concentrate in presenting the functionality of the demonstrated tool rather than explaining how to , choose menu-items and so on.

Figure 5 Remote Participant with virtual projection wall in TELEPORT's virtual extension

Position and size of the virtual projection wall can be easily adjusted and either included or excluded from the virtual extension of a display room. This is particularly important for an interactive seminar, where participants are asked to complete specific tasks or tests, or answer electronic questions. If this is a requirement, then different virtual projection walls can be inserted next to the participants whenever this is necessary. Since BSCW is used during the session, the process of generating reports, lists of questions and answers or whatever might be necessary after the session becomes easier. Participants might even be able to "walk out" of a session having all the necessary information downloaded into their notebook or the site's computer system for future reference.

4.2 Meeting Example

The same approach can be used to support meetings of geographically dispersed groups. In particular, preparation of the meeting is very similar to that of a seminar. A major difference between a meeting and a seminar situation, is that during the co-presence session, the level of participation of group members is more equal. Group members from all sites would need to exchange ideas and display electronic documents that might support their ideas and arguments on an equal base. The way this is achieved is the same as in the seminar case. However, consideration must be given as to the number and size of virtual projection walls because of the limited space of the display rooms and their virtual extensions. It might, for example, be better to use only one virtual projection wall for each group's site rather than one for each group member. Figure 6 shows an example of co-presence and co-working between two remote sites. One participant and the virtual projection wall are combined with the virtual background and the mixed image becomes the virtual extension of the other participant's display room.

Figure 6 Session between two remote sites as seen from within a TELEPORT's display room

Finally, more than two sites can be connected. In this case, the video image from all the other locations is combined and projected into the virtual extension of each participant. A co-presence and co-working session with three locations is shown in Figure 7. Occasions were more than one virtual projection walls are used in one location, are possible. However, consideration must be given as to the size of the surfaces and the number of group member's participating in the meeting, due to the size of a TELEPORT display room.

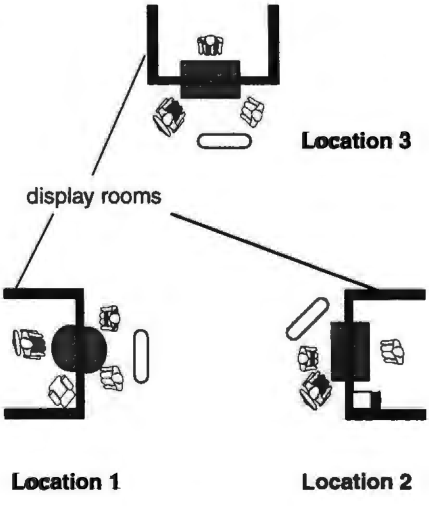

Figure 7 co-presence and co-working from three remote locations

5. CONCLUSIONS

In this paper we have presented an approach for co-presence and co-working in a distributed office. The approach integrates two systems developed at GMD, namely TELEPORT and the BSCW Shared Workspace System. TELEPORT is a teleconferencing system that merges virtual and real environments by the use of wall display surfaces and viewer tracking provides the sensation of face-to-face meetings. The BSCW Shared Workspace System provides basic facilities for collaborative information sharing, activity awareness and integration of external applications based on the World Wide Web architecture. The approach presented in this paper provides support for co-working by integrating the functionality of the both systems. In particular, group members at different sites use the BSCW system to prepare artifacts needed in the co-presence session. During the session these artifacts are textured mapped onto a virtual projection wall and combined with video imagery of the remote participants. The usefulness of the approach has been presented by the use of two scenarios. However, there is evidence that the results of our work could be of interest for a broader application domain in today's distributed offices. In future work we will investigate specific needs of different applications domains to enhance the usefulness of our approach.

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FUNCTIONAL VERSUS CONSCIOUS AWARENESS IN CSCW-SYSTEMS

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Abstract

An increasing number of groupware systems aim at providing users with awareness information—information about the presence, activities, and availability of the other users of the same system. However, most of these systems are designed from a functional rather than a human-oriented point of view. In fact, designers of awareness features more often focus on technical challenges and realisability than on adequate support of group awareness information. In this paper, we relate empirical findings of human behaviour to existing groupware systems identifying requirements for future human oriented groupware systems. When applied from a methodological perspective, this approach leads to the utmost human-centred utilisation of technology to support task accomplishment.

1 Introduction

The search for a research strategy 'for evaluating the effect of awareness mechanisms on users and organisations' [15] has led to the insight that there is a need for the development of a comprehensive and nevertheless detailed concept of awareness. Furthermore, a need for the introduction of methods and measurements to evaluate group-aware collaborative applications has been identified. These issues have been hardly addressed so far. This paper, therefore, does not only revisit potential concepts of group awareness for CSCW systems, but also claims that awareness concepts stemming from social sciences have to be brought to practical use in future collaborative applications.

In order to achieve the integration of the results of empirical studies of human behaviour (in particular, small group research) with technology-driven approaches, we started with an analysis of the concepts of awareness in computer science as well as in social sciences. Based on these findings we have brought these concepts together. This approach has two major advantages: firstly, it enriches the explanation and understanding of awareness for system development and, secondly, it enables a

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new generation of artefacts (as part of socio-technical systems) that provide human-oriented awareness features for CSCW systems.

The results of this approach are presented as follows. In the following section we briefly introduce existing groupware systems and their features with respect to awareness. It turns out that existing collaborative applications providing awareness information do not only support awareness incompletely, but also lack consistent support within the single types of awareness. In literature different forms of awareness (stemming from small group research, aviation and social psychology) have been found, which offer explanations and definitions of the terms and concepts used in varying details. We list the results in the subsequent section. In the same section we introduce different forms of operational definitions of the hypothetical construct of awareness—different kinds of human behaviour with respect to awareness.

We then analyse in how far certain features of the examined categories of groupware systems support or enable particular forms of human-oriented awareness and which systems have to be enhanced with behaviour-oriented awareness features. The final section concludes the paper by wrapping up the objectives and the achievements. We also identify areas for further research on mutual adaptation and integration between the social sciences and CSCW—research that we started in this paper and that should become continuous and more accurate.

2 Awareness in CSCW and Groupware Systems

In the last decade while CSCW has emerged as a research field on its own, many groupware systems have been developed. Multifarious taxonomies try to order them according to various kinds of dimensions. Dimensions discussed are time, space, task, sharing, and so forth [c.f. 4, 9, 12]. However, none of these taxonomies uses the provision of group awareness information as an explicit dimension.

The groupware systems providing awareness information are distinguished according to the temporal nature of the cooperation they support (asynchronous, synchronous, semi-synchronous). Asynchronous groupware systems support cooperation at different times; synchronous groupware systems support cooperation at the same time; and semi-synchronous groupware systems apply the notion of place rather than of session or meeting. Table 1 provides the addressed categories of collaborative applications as well as typical instances of artefacts.

Table 1a. Feature Description of CSCW Systems which focus on Awareness.

Classes of group-ware systems providing awareness	Features to provide group awareness information	Awareness information provided
1. Asynchronous groupware systems (e.g., Session Capture & Replay System [14])	Captures users' interactions with any application and storing the data into a session object; capturing of users' actions; key feature: • replay of users' past actions (what-you-see-now-is-what-I-saw-then, WYSNIWIST)	Workspace awareness
2. Synchronous collaborative text and graphic editors (e.g., GroupDesign [2])	Drawing tool for Apple Macintosh computers; was designed for collaboration among a large number of users creating structured graphics; key features: • manipulated objects marked with busy icon in colour of user • graphical and audio notifications about changes ('echo') • search other users' positions ('localisation mode') • objects have colour of user who created or last modified object ('identification mode') • history mechanism	Workspace awareness, audio and video echo
3. Synchronous collaborative editors with awareness about actors (e.g., ClearBoard [11])	Shared drawing medium for two remotely but synchronously collaborating users; key metaphor applied is 'talking through and drawing on a transparent glass window'; key features: • image of head of drawing partner is overlaid with image of shared artefacts • camera focusing on the head of the participants allows the transmission of facial expressions and gestures ('gaze awareness') ■ simultaneous gesturing and drawing	Workspace awareness, gaze awareness
4. Synchronous collaborative virtual environments (e.g., MASSIVE [7])	Virtual Reality (VR) conferencing system supporting multimedia communication through audio, video, and text, and supporting partial mediation—that is, users' awareness of others is measured in spatial terms; key features: • simultaneous meetings can be held at the same time • user are embodied as blockies showing their capabilities (e.g., a 'textie' representing users with text terminals) • notion of space—distance between users influences media they can use and awareness information they can get from each other and they emit themselves	Informal awareness, social awareness
5. Semi-synchronous virtual office environments (e.g., DIVA [17])	Virtual office environments strive to seamlessly integrate various groupware systems into a single virtual environment. Integration concerns functionality of groupware systems like communication, cooperation, and awareness as well as modes of interaction such as real-time cooperation and asynchronous cooperation; key features: • office model integrates people, documents, and desks for collaboration • rooms can be assigned special purposes	Informal awareness, workspace awareness
Semi-synchronous event notification systems (e.g., 6. Khronika [13], 7. GroupDesk [6])	Khronika is a system, which increases people's awareness of what is going on around them over time by event browsing and notification in a X11 environment; it receives information about events from various clients, stores it in a database, and delivers notifications about this information to users who are interested in them; key features: • users then can subscribe to the event types they are interested in ('the recipients are placed in control'); the event demons map a user's personal interests with the data in the database and notify them accordingly • depending on access rights to the events, Khronika can provide information about all activities of all users currently logged in and all time and system events • GroupDesk provides awareness information about present as well as past activities and about coupled events, which are events that are related to the current activities of a user, as well as uncoupled events, which are events that are not directly related to the current activities of a user but which are of general interest.	Workspace awareness

Table 1b. Feature Description of CSCW Systems which focus on Awareness.

Classes of group-ware systems providing awareness	Features to provide group awareness information	Awareness information provided
8. Semi-synchronous WWW-based systems (e.g., CSCW3 [8])	Computer-Supported Cooperative World-Wide Web tries to 'populate' the Internet—that is, Web pages are considered as rooms, which users enter when they visit a page; users are provided with awareness information about others visiting the same page and can communicate with them; key features: • users are provided with information about other users, who visit the same Web page or who recently left the page ■ users can meet other on Web pages and exchange information and bookmarks • users can chat in IRC-like chat tool and send various kinds of smiley-icons • users can search colleagues logged in on the same CSCW3 server • users can provide their profiles to others • users can annotate Web pages for others • users can navigate jointly through the Internet • users can hide their profile it they want to navigate anonymously	Informal awareness, workspace awareness
9. Media spaces: constant awareness systems (e.g., Portholes [3])	Constant awareness systems (also known as whereabouts or availability systems) permanently provide information about presence, activities, and availability of others in virtual space; the goal of the Portholes project was to demonstrate that awareness can be supported across long distances and nevertheless be useful. Digitised video images were sent from Rank Xerox Research Centre in Cambridge, UK, to Xerox PARC in Palo Alto, California and vice versa. Key features: • pvc system displays images of others • edison system additionally plays audio sequences • view-master system displays images of public places	Informal awareness, social awareness
10. Media spaces: social browsing systems (e.g., Montage [18])	Social browsing systems are based on the assumption that a user wants to know if a certain person is present in the virtual space or, more general, who else is present in virtual space; Montage uses a hallway model; key features: • hallway model allows users to navigate virtual hallways and glance into others' offices; glances give a good impression if the user is in her office and if she currently wants to be approached • if the doorway is open, the cruising person can peek in; peeking is reciprocal—that is, a person who is monitored can also see the observer • users can put signs on their door saying that they are available, busy, and so forth • from this reciprocal glances, full-featured desktop video conferences can be started immediately	Informal awareness

3 Understanding of Awareness in Social Sciences

After we have completed the review of the state of the art in the development of groupware and CSCW-systems we proceed with the results of our in-depth literature review in social science. The findings comprise possible concepts of awareness as well as a variety of operational definitions—that is, human behaviours reflecting one or more of the identified concepts. In this section we provide a compilation of concepts and assign human behaviours to the identified categories of awareness. Empirical studies of human behaviour have revealed several understandings and explanations of awareness (cf. Table 2).

All the forms of awareness we introduced have been empirically tested (cf. respective papers). With the exception of objective self-awareness, it has been found that awareness significantly influences the performance of work tasks, and, in case of proper enactment and support significantly reduces human errors and increases the accuracy of work results (cf. respective papers). Hence, human-centred design does not only require a focus on group awareness as featured by groupware systems but also the consideration of different forms of awareness stemming from social sciences. Different operational definitions of the hypothetical constructs of awareness have been found. In Table 2 eighteen characteristic forms of awareness—that is, forms of human behaviour—are presented.

Table 2. Definitions of Various Kinds of Awareness.

Type of awareness	Definition
Group awareness	A specific set of behaviours as characteristic of intimate, primary groups [1, p. 82f]: 1. affective behaviours in the form of (verbal and non-verbal) expressions of emotions: a) positive sentiments (rewards),b) negative sentiments (punishment), c) general affect (neither rewards nor punishment) 2. collective orientations: primary group members experience a sense of interdependence with one another, and a mutual welfare in a joint venture 3. particularism: is an act in which a given individual orients towards another on the basis of other's possessions of properties (i.e., qualities or performances), which bear a distinct relation to the actor's own properties (i.e., traits or statuses) 4. diffuseness: behavioural occurrences of diffuseness are typified by an actor's display for broad interest in another
Social awareness	Eight social awareness forms [16, p. 321]: 1. awareness of one's own experience from the self: I'm feeling angry 2. awareness of one's experience from the perspective of another person: She's reacting as if I'm angry—maybe I am 3. awareness of the other's experience from the self perspective: She has no right to be so mad. 4. awareness of another's experience from that person's perspective: I'd be furious if I were here, too 5. awareness of one's own appearance from the self perspective: scrutinising ourselves in a mirror. 6. awareness of one's own appearance from another's perspective: suddenly noticing someone is observing us 7. awareness of another's appearance from our own perspective: Why doesn't he comb his hair? 8. awareness of another's appearance from that person's perspective: we notice that a teenager seems obsessed with her complexion.
Task specific awareness	Task specific awareness of the working process [5, p. 251] can be demonstrated by the 1. adequate description of the used strategies (consciously monitoring and regulating this strategies), and 2. by detailed reports on the difficulties in understanding the task
Situation awareness	The three level development of situation awareness [10, p. 2395f]: 1. Level 1 concerns the operator's ability to perceive elements in the current situation. 2. Level 2 situation awareness integrates information concerning the current process state derived at Level 1 into overall comprehension of the current situation. 3. Level 3 situation awareness concerns the projection of the current process state into the near future. The importance of this future projection is that the operator must assess now if the anticipated future process state is perceived as disparate with operational goals and plan mitigating actions accordingly
Objective self awareness	Changes in performance may occur subsequently because of an increased motivation to reduce the intrapersonal discrepancies. The individual's performance can suffer, if the individual spends to much energy in the current process of self-attention, because he/she does not have enough resources to accomplish her task.

4 Revisiting Awareness

Given the results of the previous sections—capturing both the recent developments in CSCW and the findings of empirical research—we proceed according to the objectives of our study. The objectives were:

1. to evaluate existing groupware systems in how far they enable or support different forms of awareness from a human behaviour perspective
2. to identify those deficiencies of existing groupware systems that have to be overcome to support human-oriented awareness

In order to achieve this shift from technology-driven development towards human-centred design of socio-technical systems we have specified a scheme for comparing technology-driven approaches to a behaviour-oriented understanding of awareness. Such a scheme does not only enable the interpretation of existing technical features as enablers of different types of human behaviour in the context of awareness, but also the check whether the enabled human behaviour corresponds to the empirical findings, and furthermore, the identification of required improvements of existing collaborative applications to foster the development of human-oriented socio-technical systems.

In Table 3 the results of the steps addressed have been summarised. The instances of groupware systems featuring awareness as listed in Table 1 have been put into the context of human behaviours as presented in Table 2. The capability of the sample systems and their degree of support have been (re-)rated with respect to the awareness behaviours. The entries in Table 3 reflect the results at a glance. We have marked the capability of a system to enable or support a particular form of awareness with 'X' at the corresponding cross cell.

Our results in Table 3 show that the groupware systems only support a limited number of human behaviour in a very broad scattering. 'Collective orientation', an aspect of group awareness, 'awareness of another's appearance from our own perspective' (social awareness) and 'the operator's ability to perceive elements in the current situation' (situation awareness) are those forms of human behaviour that are primarily supported. ClearBoard, Diva and CSCW3 provide most of the characteristics, namely ten out of eighteen forms of human behaviour. Social awareness is supported in systems like CSCW3 and through emoticons such as ;-). These emoticons represent social attitudes as well as personal feelings about certain topics or persons. They can be placed anywhere along textual information. However, the use of these symbols does not seem to have established certain social understandings or standards among user communities. One form of task awareness, the 'adequate description of the used strategies' can only be achieved implicitly, whereas particularism remains still unsupported. Three out of eight forms of social awareness and 'the projection of the current process state into the near future' (situation awareness) has not been implemented as particular features as well. Finally, non of the investigated groupware systems supports all aspects of one kind of awareness.

Table 3. Groupware Systems in the Context of Human Behaviour-Oriented Categories of Awareness

Groupware Systems [illegible] Awareness [illegible] Awareness	1	2	3	4	5	6	7	8	9	10
Group Awareness										
1. affective behaviours			X	X	X			X	X	
2. collective orientations		X	X		X			X	X	X
3. particularism										
4. diffuseness				X	X			X	X	
Social Awareness										
1. awareness of one's own experience from the self								X		X
2. awareness of one's experience from the perspective of another person			X							
3. awareness of the other's experience from the self perspective			X		X					
4. awareness of another's experience from that person's perspective			X		X				X	X
5. awareness of one's own appearance from the self perspective								X		
6. awareness of one's own appearance from another's perspective										
7. awareness of another's appearance from our own perspective			X	X	X			X	X	X
8. awareness of another's appearance from that person's perspective										
Task specific awareness										
1. adequate description of the used strategies	X*	X*	X*		X*	X*	X	X*		
2. detailed reports on the difficulties in understanding the task	X		X		X			X		
Situation Awareness										
1. the operator's ability to perceive elements in the current situation		X	X	X**	X	X		X		
2. overall comprehension of the current situation	X	X			X	X		X		
3. projection of the current process state into the near future										
Objective Self Awareness										
		X	X feasible						X***	X***

* implicitly ** limited to the actor's environment *** monitored person

In order to provide the entire spectrum of a particular kind of awareness, several improvements are required from a technical perspective. For instance, the Session Capture and Replay System only provides an implicit description of the used strategies for awareness. Visualisations like bar charts and flow diagrams could help users in being aware of the used strategies.

The ClearBoard system got best ratings concerning social awareness. However, it does not provide users with information about their own appearance (points 5 and 8 in Table 3) and it does not provide information about the effect(s) of the own appearance to other users. Overview diagrams providing users with miniature overviews of the entire collaborative setting (including both actors and their actions) could improve social awareness information support of ClearBoard.

All technical features have to take into account the social dimension that actually has to be addressed for the forms of awareness to be enabled or supported. Due to space limits we can only give an example for group awareness. For instance, none of the existing groupware systems supports particularism. However, support for particularism is a very important criterion for effective group work—it is essential to form a transactive memory system. A transactive memory system is a 'set of individual memory systems in combination with the communication that takes place between individuals' and is 'more than its individual component systems' [19]. 'The individual gains other's domains of expertise, of course, but also gains access to the knowledge that is created through integration within the transactive memory. [...] Moreover, a group with a smoothly functioning transactive memory is likely to be effective in reaching its goals and will thereby satisfy its members.' [ibid., p. 197]. The accountancy of the social-, since behaviour-oriented dimension of awareness has to be considered as a prerequisite for implementing human-centred design specifications. However, current description or specification languages are not capable to reflect this dimension to transform semantic knowledge to syntax structures.

5 Conclusions

Based on the results of the latest discussions of awareness with respect to collaborative applications we have developed and followed a research agenda towards embedding empirical findings concerning awareness into CSCW-system development. The multi-step procedure involved the review of existing technical features as well as the structuring of results in social sciences (studies concerning human behaviour). As such, the demand for interdisciplinary research in the field of CSCW has been met and finally led to requirement definitions for artefact development.

The epistemological analyses in this paper clearly reveal that existing groupware systems only partially support behaviour-centred awareness, and that some important kinds of behaviour are not supported at all (cf. Table 3). Further investigations are required. They are primarily concerning methodological issues.

First of all, the designers should be aware of what kind of awareness their systems should support according to the classification of awareness stemming from social sciences. Following the traditional classifications proposed by CSCW researchers will lead to a continuous neglecting of empirical results (i.e., the social realities users of collaborative applications are part of). On the long run, the resulting methodological and conceptual diversification of social sciences and CSCW will be continued—a process that does not facilitate, but rather hinder the integration of previously isolated fields.

Secondly, it is necessary to enrich the existing groupware systems with the identified features. This way, holistic support of the type of awareness they aim at becomes feasible. However, the results of these improvements have to undergo critical review: Empirical evaluations of the group performance achieved through the novel mix of features for the different types of awareness are required. Following this procedure, novel behaviours might be recognised that in turn lead to novel features, and so forth.

According to this concept, a truly interdisciplinary discourse can be established, since it does not only lay ground for novel conceptual and methodological inputs for CSCW and the social sciences, but also brings benefits in terms of synergistic effects for group members. The latter has to be considered as a prerequisite towards human-centred system design.

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EXTENDING WORKSPACES FOR KNOWLEDGE SHARING

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Abstract: The paper begins by distinguishing between systems that support communication and those that facilitate knowledge sharing. It then describes ways of specifying workplaces for communication illustrating them by examples. The workplace specifications are then extended to support knowledge sharing.

1. INTRODUCTION

This paper defines a way of specifying and developing electronic workspace networks for distributed, real or virtual organizations. A workspace network supports multiple groups of users to work to a common goal. A workspace in the network is a collection of objects and processes made available to a computer user. The paper concentrates on ways in which workspace networks can support knowledge sharing rather than communication in organizations. Knowledge sharing goes beyond communication and requires processes specific to knowledge development as those found in recent literature. In distributed environments, these processes include the ability to quickly adapt to different terminologies in distributed systems, form shared perspectives (Boland and Tenkasi, 1995) even when different terminologies are used, and create new knowledge (Riggins, 1998) needed to achieve organizational competitiveness. Knowledge sharing includes trader environments (Kratz and Rose, 1996) where information needs are exchanged using mediation agents. It also includes support for seeking advice during workflows (Abbott, 1996) as well as specific discussion structures for knowledge development.

The need for knowledge sharing systems is seen as important to improve organizational effectiveness. Grant (1996), for example, sees knowledge creation and integration as crucial for organizations developing new capabilities and placing products on markets. Knowledge development is also seen (Grant, 1996) as a combination of tacit and explicit knowledge. Tacit knowledge is seen as particularly important because of increased specialization within the workspace. Common ontologies must also be established within distributed environments to support these activities. Systems that support knowledge sharing will be required to provide easy access to specialized knowledge, and allow it to be brought together to address new organizational goals. The other dimension of such support systems is the ability to specify a variety of governance structures (Jones, et.al. 1997) to encourage effective knowledge development to ensure the relevant experts are included in discussions. Such governance must be easily established and modified for effective knowledge development.

The paper suggests that workspaces are needed to integrate knowledge primitives with communicative actions thus assisting users in gaining access to increasingly specialized knowledge and furthermore to develop it to gain competitive advantage. Such knowledge based workspaces must satisfy a number of criteria, in particular they must provide access to both explicit and tacit knowledge and provide direct support for knowledge creation. The paper uses a specification method using an ontology grounded in communications terms (Hawryszkiewycz, 1997) and extends it to include knowledge sharing in cooperative environments.

Finally the paper defines an infrastructure that goes beyond the basic telecommiunications facilities provided to build communication systems - the speed and cost of lines and so on. It emphasizes services that can be used to easily construct workspaces that integrate ways of using communication facilities for knowledge sharing. The paper describes the functionality that is provided at each infrastructure level and show a good design should ensure a match between all the levels.

2. A COMMUNICATION MODEL OF WORKSPACES

Analysis of work structures often identifies major activities that are here described in terms of rich pictures (Checkland and Scholes, 1990). The rich picture in Figure 1 describes the activities used in planning research programs in the World Health Organization (WHO). The rich picture shows activities, as clouded images. The communities in the activities are shown as labeled icons, and major documents used in the activities as rectangles. Thus field workers, researchers, planners, regional officers and advisers are the roles. One major activity is to "collect and present information on health status", which involves three of the roles and uses both reports and field questionnaires to produce a HEALTH PROFILE.

The roles indicate the broad communities and their needs and can be used to identify the benefits they expect. These benefits may be different for each type of role. For example, field workers may be looking for support to get access to latest medical reports and equipment. They may also be looking for better communication inputs to their regional offices. Planners may be looking for tools that lead to better resolution of conflicts and better decisions without the need of extensive meetings. Continuation of design at this detailed level becomes quite awkward as one is always dealing with elementary concepts. The approach of using workspaces reduces the level of detail by specifying systems in terms of higher level generic workspace types. The elementary concepts become the workspace variables that are used to customize workspace types to particular needs.

Thus each activity is now defined as a workspace that can then be expanded into workspace networks as detailed requirements are identified. Workspaces themselves are defined in terms of the core concepts to model the variety of processes, ranging from highly planned to situated work. The core concepts used to describe workspaces are the *role*, *actor*, *interaction* and *artifact* (Hawryszkiewycz, 1997). The role defines a responsibility within a group whereas an actor is the physical entity that carries out the responsibility. An interaction is a group or roles that work together to achieve some goal. An artifact is an object used in the interaction. The workspace provides a rigorous human role structure, and flexible ways to dynamically build evolving communication processes.

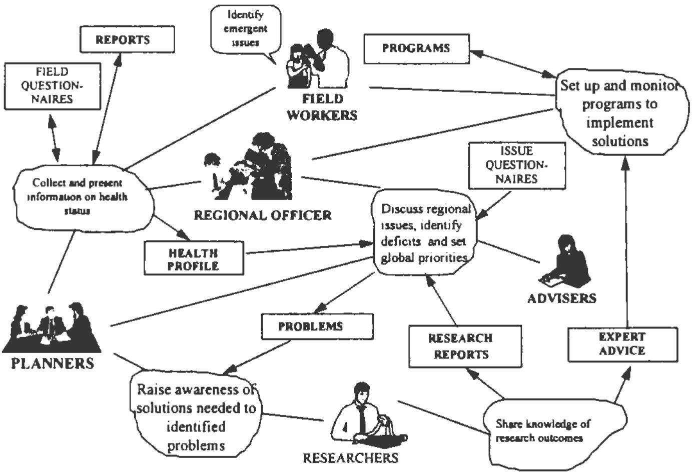
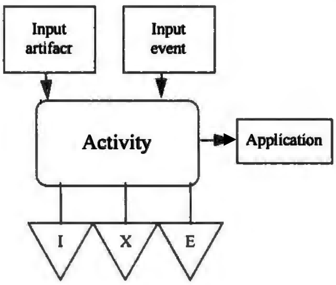


Figure 1 - A system description in terms of core concepts

2.1 Specifying requirements using workspace communication nodes

The workspace specification is derived from De Moor's method (1997) and suggests the structure shown in Figure 2 as a basic representation for communication together with norms that specify role behavioural patterns. The structure centers on an activity that takes a set of input artifacts to produce a set of output artifacts. The activity is initiated by some input event or artifact state. The activity itself is carried out by any number of interactions that involve set of roles. The triangles are role sets and are the placeholders of actors. Figure 2 shows three kinds of role sets that often necessary for good communication practice. The initiator or goal setting roles (I) initiate the activity and define its goals. The activity is carried out by the executor roles (X), and evaluator roles (E) moderates the process including deciding when to terminate it, and constitute the reviews found in most quality processes.

Workspaces can support communication processes by both combining nodes into higher level nodes or expanding them into more detailed nodes. Thus each workspace can itself be a subject of a larger activity. The roles in higher level activities can change or even create new workspaces during the collaboration process. Figure 3 illustrates one such combination. Here 'Credit Applications' is defined itself to be made up of two other workspaces - checking the application and making a decision on the credit level. Each such workspacehas its own role set. The role set I0, X0, and E0 themselves decide how the included workspaces operate and the roles that can participate in them. Workspace roles can create new workspaces if they are empowered to do so. Thus roles in IO, XO and EO can define the structure of its contained workspaces. They create the roles in the included workspaces and give them permissions to carry out selected actions.



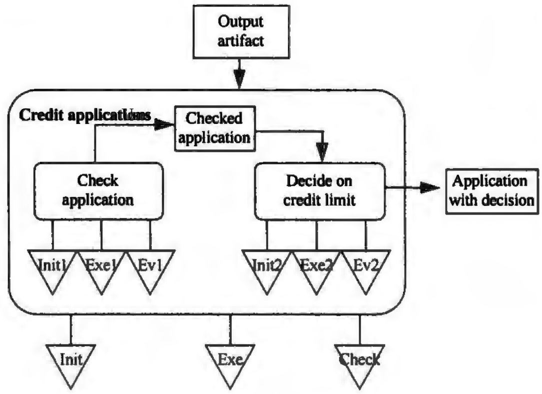


Figure 2 - An Elementary Workspace Figure 3 – Combining Workspaces

2.2 Workspace Norms

Workspace norms define the reporting relationships implied by the organizational culture. For example, preplanned processes can be easily modeled by each workspace representing each task, and outputs from one task initiate the next workspace. For the more situated process, the workspace can take longer to complete but it can adapt itself to the situation by allowing roles to create new workspaces within it as the situation develops. Norm rules include;

Role rules: Examples of role rules are those that identify those roles that must have different actors, define cardinality of role set, define actors to be included in role set and define actors to be excluded from a role set.
Action rules: Examples of action rules are those that define role responsibilities through actions assigned to roles. This strongly corresponds to the idea of empowerment in task oriented groups.
Sequence rules: These define the sequences in which actions are to be carried out.
Role relationships: These define relationships between the roles and those actions where roles must interact to produce an outcome. These rules serve to indicate the kind of communications support that will need to be provided for the roles.

3. WORKSPACE TYPES FOR COMMUNICATION

Workspaces are here characterized in a number of ways. They are:

- *information access*, where information is provided for easy access by people in the organization,

- *information exchange*, where information in the form of documents is exchanged between people or made available for their use. This can include meetings, distribution of messages, publishing of information amongst others.
- *interpersonal relationships*, where specific individuals communicate spontaneously to discuss and perhaps decide on actions to be taken, as for example, in situations where wide expert advice must be sought to make a decision, and
- *work processes*, that define the flow of work through the business alliance usually related to projects with specific goals.
- *knowledge sharing* processes that include the operations needed in knowledge sharing.

The paper first describes some systems developed to support communication and workflows and then describes extensions to knowledge sharing systems.

3.1 Discussion systems for Interpersonal relationships

The goal in such systems is to adapt the discussion structure to the natural discussion processes followed in the organization. Thus Figure 5 describes how tacit information may be gathered for use at higher management levels. There as operational level discussions reviewed by management, with operational problems put forward for management discussion. Management discussions then raise resource problems that are put forward for strategic decisions. Such structures should include the ability to define roles that are to participate in the discussion, the ways that these roles an contribute to the discussions and relationships between any number of on-going discussions. Links to organizational structure can be of value here as for example the system can ensure that all people at a given organizational level are included in relevant discussion reducing the feeling, sometimes unwarranted, of having been left out of a particular discussion.

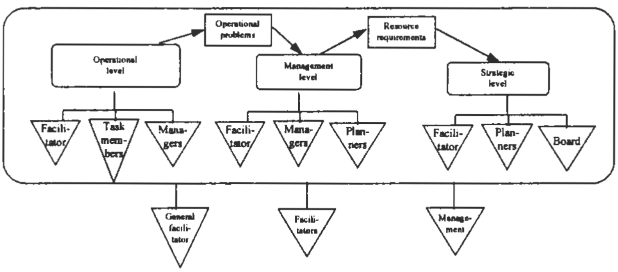


Figure 4 - Structuring discussion systems

One example have been focused discussion to identify world health problems. The idea here is to allow discussion to proceed in a controlled manner (Greiner, et.al. 1993) that can for example be used to first identify significant local needs, pass them on to a higher level regional discussion and then move significant regional issues into the global forum. A system here must provide users with the ability to specify discussion structures, a give various roles different abilities in these structures.

3.2 Workflow Systems

A structured preplanned system is illustrated in Figure 5. It describes the tasks in the software engineering process. Here the roles responsible for initiation, execution and review are the manager for both initiation and execution and client for review. The software engineering process workspace is expanded into a number of tasks, Design, Develop and Accept to carry out the process activities. These tasks combine to take a requirement to produce a product. They are carried out in a sequential manner with intermediate being the designs and systems. Each of the workspaces in the software engineering process can themselves be expanded into their more detailed tasks.

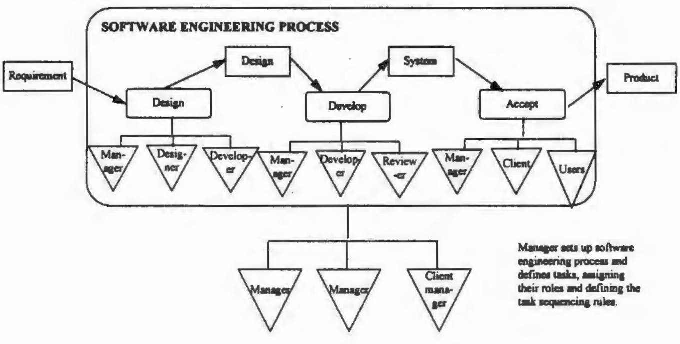


Figure 5 - Modeling closed processes

The definition of such tasks is the responsibility of the management roles. Apart from defining the structure, the process rules must also be defined when setting up a workspace. Part of the definition is the assignment of roles to each of the tasks. Furthermore role constraints may be included, such as for example the evaluator roles of tasks cannot be included in the executor roles. Organizational links can be used here to find the most relevant experts for review processes during the creation of workspaces. There is the possibility here of defining task structures to meet organization quality standards.

One example of such a process is software engineering. Quality standards in software engineering have been studied for a considerable time and good practices widely discussed. These include the need to include verification procedures in tasks through reviews. Tools to support software engineering should provide the facilities to enable such practices to be instituted and monitored. Particularly important in such tools (Gorton, et.al., 1987) is to provide the ability to ensure review processes are carried out and proper approval is instituted. Thus a standard task format has been developed to enable tasks that include such processes to be easily created. This closely corresponds to the model shown in Figure 5 and is illustrated in Figure 6.

Thus the task has a number of standard actions as defined by the top menu. Task users are required to execute these actions in prespecified ways. Furthermore, norms are often included to assure quality, as for example, actors that take reviewer roles cannot also take initiator or executor roles in a workspace.

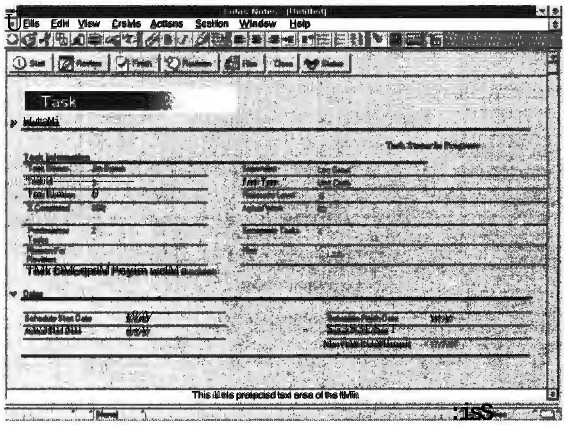


Figure 6 - A Task form for Software Engineering

4. EXTENDING TO KNOWLEDGE SHARING

Knowledge in this case goes beyond subject level knowledge but also includes collaborative and organizational knowledge as shown in Figure 7.

Collaborative knowledge - Collaborative knowledge defines the best way to carry out activities within an organization. It supports tasks in getting any related information, finds the best ways to get consensus and reach agreement.

Subject matter knowledge - Identifies the location of knowledge and requires a broad level ontology to evolve as knowledge is developed.

Organizational knowledge - Define the objectives of workspaces and tasks needed to achieve them. Defines the knowledge needed to carry out the tasks. Contains information of the location of any tacit knowledge.

4.1 An Infrastructure for Knowledge Sharing

The infrastructure for implementing knowledge based systems is shown in Figure 8. It sees the infrastructure in relative terms. To the organization, telecommunications becomes an important infrastructure. However, to the user, the infrastructure are those facilities that are provided to directly support work practices. Thus in the first instance word processors are one such part of the structure, although these are oriented more to task support rather than cooperative system support. E-mail is another part of the infrastructure, although e-mail on this own is generally only useful for two way interchange and becomes difficult to manage where close collaboration among a large number of people is to be supported.

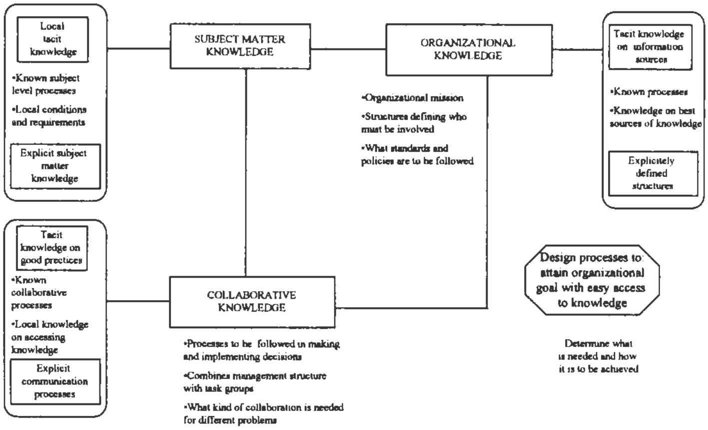


Figure 7 - Knowledge Framework

For this reason this paper distinguishes between what are the networking technologies and what are value added services. Networking technologies are technologies that are provided to build systems that encourage the sharing of knowledge. However, they still often require considerable development before they can be used in the work practices of particular organizations. This is where the value added services come in - these can be directly adapted to such practices. The networking technologies then become the infrastructure to the developers of value added services.

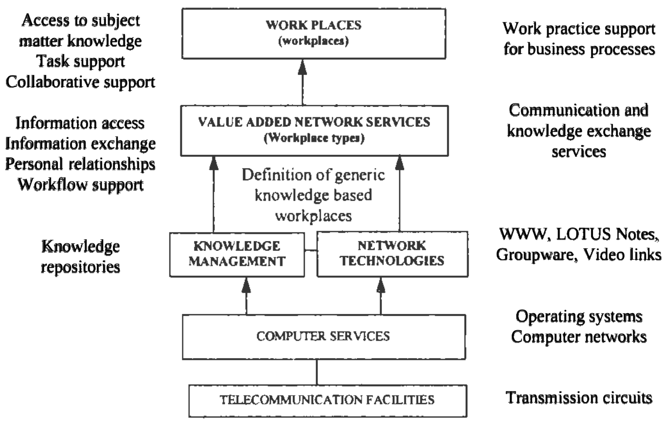


Figure 8 - Infrastructure levels

The level should provide the ability to compose workspaces from predefined workspace and agent types. Workspace composition includes selection of agents and integration of knowledge sharing modules. The major workspace components are shown in Figure 9.

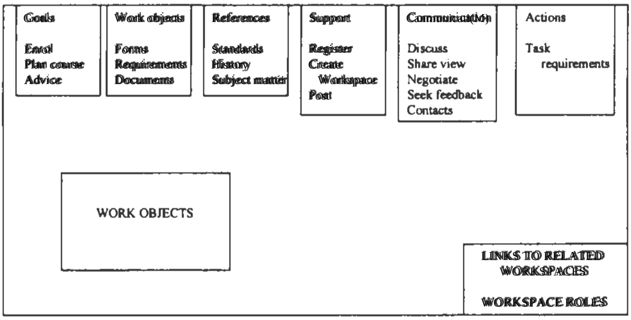


Figure 9 - Workspace components

The workspace includes a set of goals that are used to initiate processes within the workspace to attain the goals. Thus goals in a workspace set up to guide clients enrolling in problems may do things like set up discussions with the most suitable organizational experts, and then create another workspace for enrolment. Once goals are more clearly elaborated reference documents may be found and presented to the user. These activities can be implemented using software agents (Hunhs, 1998, Nwana, 1997) for information access have also been reported, although these concentrate on searches of explicit rather than tacit knowledge.

4.2 Defining Actions for Knowledge Sharing

Agents can be used to create a variety of cultures for knowledge sharing. One of these is sharing through knowledge trading. Another are processes set up to collect tacit knowledge, which is described following. Figure 10 defines a scenario for defining communication patterns for abstracting tacit knowledge. Here detailed, often personal information is collected and refined into a higher level view. An example in such abstraction may be a field worker defining lack of access to medical instruments. This is then discussed locally to determine if it is local or widespread in the region and if so than it becomes a regional issue. The rich picture in Figure 1 shows that higher level abstraction is achieved by;

Field workers raise issues, which become part of a local discussion forum,
The discussion forum is managed by a forum coordinator, which is a proposed role to be defined in a region,
If the field worker and regional agree that this may be a general regional issue then it is entered into the regional discussion forum. In this case questionnaires may be distributed to gather information from the whole region,
If regional discussion sees the issue of regional significance then it is entered on a central agenda.

The discussions can be retained and become part of organizational memory. Semantically it supposes a number of FORUMs to be proceeding concurrently.

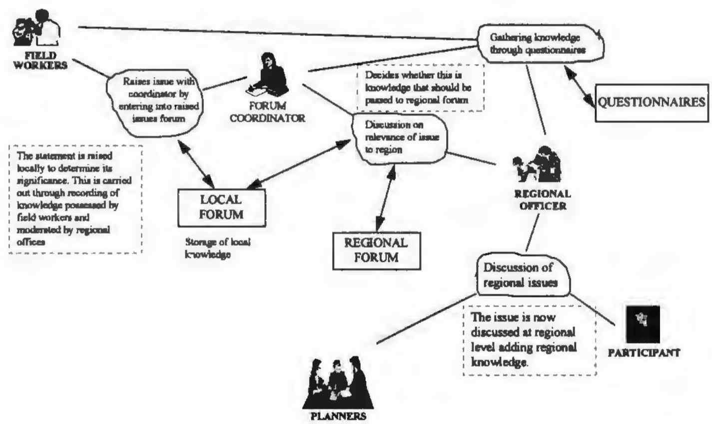


Figure 10 - Scenario for knowledge abstraction

The next step is to derive some of the fundamental building blocks that can be used to support such discussion scenarios. This needs a set of standard objects together with a set of language statements to operate on these objects. Object orientation was used to identify such building blocks. The first step is to develop an event flow diagrams like that shown in Figure 11 to represent the scenarios. This is based on Jacobsons (1992) notation with interfaces shown for the roles.

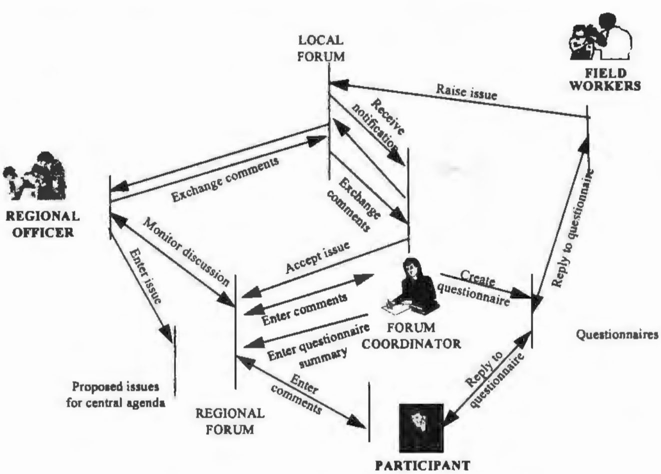


Figure 11 - Developing event flow diagrams

The event flow diagram can be converted to an object model like that shown in Figure 12, to begin to identify the basic objects. In this conversion to the object model, the objects in the event diagram are modeled in more detail, for example showing that a forum can contain a number of statements with comments made against each statement.

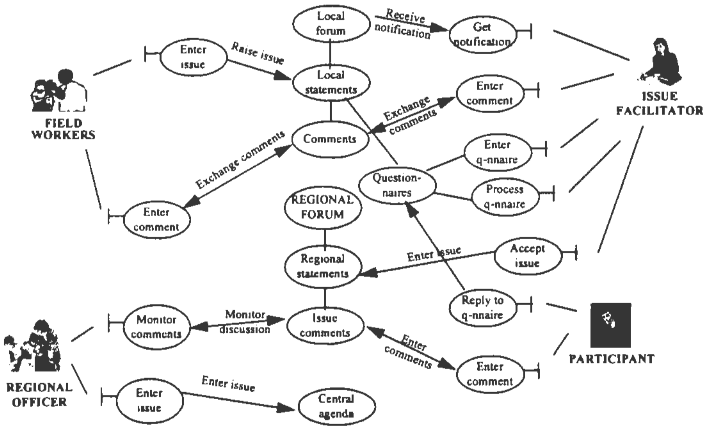


Figure 12 - Object Model

The major objects in this model are then defined even more precisely in terms of their data items and methods as shown in Figure 13. These show a number of object classes, each composed of a number of data elements and methods together with roles that can use the object. Data elements labeled as 'Link' become links to other objects that are used to realize discussions. Thus for example, the statement link can be used to include or link any number of statements in a forum.

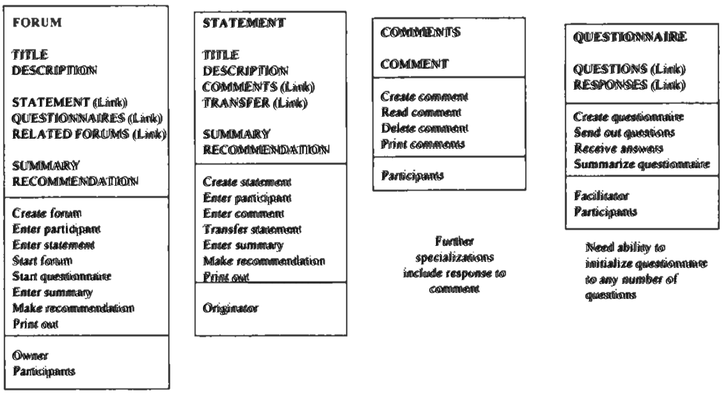


Figure 13 - An Object Structure

A set of statements for supporting the discussion semantics has been defined by examining the methods for the objects. The language is based on the idea of defining discussion FORUMS and controlling their growth in an orderly manner. The statements, which are implemented as discussion database commands, include:

Create FORUM
Create EVALUATE STATEMENT (Title, Description) {with COMMENTS }, with (PARTICIPANTS } (related to FORUM-2 }in FORUM

Create FOCUS STATEMENT (Title, Description) {with COMMENTS } with {PARTICIPANTS } {related to FORUM-2 } in FORUM
Add COMMENT
Add QUESTIONNAIRE {to judge ASPECT }
Raise ASPECT {with COMMENTS }in FOCUS-STATEMENT
Move STATEMENT
Generate STATEMENT-1 in FORUM-1 from STATEMENT-2 in FORUM-2

This defines the possibility of flexibly defining new statements within the context of any current discussion to explore some point. For example, while focusing on issues a facilitator may decide to evaluate some issue raised and thus add a statement to the current FORUM. The result becomes a discussion network that can grow, as indeed happens in most organizations. The building blocks can be used by agents to construct discussion networks consistene with the organizational structure.

5. CONCLUSION

The paper described the evolution towards using communications to support knowledge based organizations. It first described the communications framework in terms of a workspace model with some examples and then extended the framework with knowledge based functions. The extension included an infrastructure for organizational knowledge and software agents that use this infrastructure to build knowledge based workspaces.

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Telecooperation as working-together

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Abstract

The need for telecooperation is obvious. However, what is not obvious is what this notion means and what social demands such cooperation may imply. To clarify this is the intention of the paper. As a first step the paper performs an etymological analysis of the words telecooperation and telecoordination. Such an analysis indicates that cooperation happens when people engage in the production of a work as if "one mind or body." Where their activities fuse together in a way that make the suggestion of separation seem incomprehensible. In the work they do not merely aim to achieve an outcome, they also "insert" themselves "in" the work in a way that make it a human achievement rather than a mere product—this is cooperation as working-together. With this notion of cooperation in mind the paper then proceeds to do an analysis of the social conditions for cooperation as working-together. It shows, using the work of Wittgenstein, that language is fundamental to cooperation and the sharing of knowledge. The paper proceeds to apply these ideas to the issues of groupware and other cooperative technologies to indicate that we should expect telecooperation to be successful in very limited and specific social contexts. The paper therefore concludes with the suggestion that it may be more prudent to focus our attention and resources on the support of telecoordination rather than telecooperation.

1. Introduction

The need for telecooperation is obvious. In today's global economy where the drive for competitive advantage has become all pervasive, 'working at a distance' has become an imperative [4]. In fact oiganisational boundaries and the work/home distinction is becoming increasingly difficult to maintain. Under the pressure of costs and customer service, 'waste' such as commuting, office overheads, business travel, and so forth, are undesirables that are increasingly becoming the battleground in the drive for competitive advantage. In the information economy these *time* and *space* waste elements have replaced the previous 'man, material, and machine' waste categories of the industrial economy—commuting time is now the 'downtime' that need to be eliminated.

In response to these competitive pressures we saw the steady adoption and use of information technology in automating organisational work. However, with the convergence of information and communication technology the technological backdrop for this new competitive arena came together in a wholly different way. Automation (of activities) and communication (of results, ideas, and so forth) tied together in an unfolding network that seemed limited only by the rate of increase in connections and bandwidth. The creation of a network of networks that spanned the entire globe (the Internet) emerged as an obvious next step.

As these computer networks emerged they became metaphors for a new kind of work, namely net-working (teleworking, telecooperation, and so on). With the notion of net-working the traditional notion of work as a time and space located activity, became work as a distributed activity in which time and space is to an increasing degree flexible. Work, as net-work, is visualised as a network of activities bound together through information and communication technology [4, 25, 26]. In this rapidly emerging world of net-working telecooperation has become an issue in need of serious consideration. This is the intention of this paper.

In considering the notion of telecooperation this paper will argue that telecooperation is an ambivalent concept that clouds the social conditions and nature of work. It will argue that the notion of telecooperation assumes that work can be dislocated and become mediated through information and communication technology without affecting its essential nature. The purpose of this paper is to caution against such an uncritical view of mediated work.

In this regard, I would argue that there exists a *strong* view of telecooperation with the hypothesis that work mediated through information and communication technology is essentially—with minor unessential modifications—the same as working together, that is in a located time and space. Furthermore, there exists a *weak* view of telecooperation with the hypothesis that work mediated by information and communication technology is a different kind of work that requires different kinds of social and technical skills that needs to be uncovered and learnt. In this paper I want to challenge both of these views. It is my contention that they are both insufficiently attuned to the intricate complexity of the nature of work implied in cooperation. I want to argue that there are essential aspects of working *together* that can never be electronically mediated. I would obviously agree that electronic mediation does play an important role in modern organisational activities. However, I will argue that this mediation has more to do with *telecoordination* than with telecooperation; and I am not merely playing with words.

I will structure my argument in the following manner. Firstly, I will discuss the difference between telecoordination and telecooperation by doing an etymological analysis of the origin and context of use of these words. This analysis will create the basis for the second section where the nature and conditions of cooperation as *working-together* will be explored. In the final section I will outline what I believe to be the limits of cooperative technologies and its implication for the future development of such technology.

2. Tele(cooperation) and Tele(coordination)

Words are important, not because they are apparent instruments of precise definition, quite the opposite. They are important because they are fragments or artefacts that function as receptacles in which emerging worldviews *(Weltanschauung)* become sedimented [18]. With worldview I mean the values, beliefs, and 'ways of doing' that a particular social group ascribe to. We understand the Greek culture and way of life by studying the words they used and the way in which they used them—also the Hacker culture for that matter. Furthermore, if we want to participate in those particular cultures we must use those words in those particular ways and in those particular situations. Thus, my point is simply this: the words we use imply or bring with them a particular worldview, which suggests a certain way of looking at, or understanding the world, and the things we do in the world. It is this fact that make words important and which engage me to draw the attention to the particular worldview sedimented in them. The purpose of this 'drawing attention to' is not to say that these words are used in a correct or incorrect manner. The purpose is simply to allude to the worldview they may imply, and in so doing bring us to a point of critical reflection. What then is the implied worldview implicit in a word such as telecooperation?

In order to answer this question I want to look at the etymology of three words: 'tele-', cooperation, and coordination. The now mostly prefix 'tele-' originates from the Greek word *t le*, which means 'far off' or 'at a distance' [13]. The telephone is an instrument for talking to someone 'far off' or 'at a distance'. ***T le*** has a sense of removedness, and yet connectiveness, to it; such as telecommunication as a removed yet connected form of communication, or telescope as remove yet able to see form of seeing.

The verb cooperation stems from the Latin verb *co-operatio* which means 'working together' [23]. This 'working together' does not, however, refer to people merely doing things in a shared time and space, such as when two people work in the same organisation and they refer to their relationship as one of 'working together at ABC.' In order to understand the worldview implied here more clearly, we need to take a closer look at the two components of *co-operatio*. The prefix 'co-' is used in Latin, almost without exception, to indicate a 'together' that has a sense of *inseparability* such as; *co-aduno* [to unite, add, or join together]; *co-aequo* [to make one thing equal, or even with another]; *co-apto* [to fit, join, adjust together with something] [23]. This is not only true for Latin. In Modern English we also use 'co-' with this same sense of inseparability. For example when we say "they are co-accused of a crime', we do not mean that they happened to be in the building at the same time. We mean that they planned and executed the crime 'as if they were one mind.' The second part of *co-operatio* stems from the verb *opera* [service, work, or labour] [23]. Here work does not mean the mere execution of a series of activities, or the place where we work; such as 'I am going to work' or 'let me just finish this work', meaning this activity. *Opera* has its root in *opus* which rather refers to the type of work where the worker or labourer gives something of him- or herself *in* the work; such as our use of 'work' in a work of art (or craft), or a work of love [23]—or when we refer to someone's work as her *magnum opus*, her great work. In *opus* work is not an activity or an outcome, it is a way of doing in which 'self' becomes fused with the activity or artefact in a way that renders each work a unique expression (and perhaps extension) of 'self' [1]. We now have a clearer sense of the sedimented beliefs and values implied in the idea of cooperation [*co-operatio*].

To sum up: cooperation happens when people engage in the production of *a work* as if 'one mind or body.' Where their activities fuse together in a way that make the suggestion of separation seem incomprehensible. In producing the work they do not merely aim to achieve an outcome, they also 'insert' themselves in the work in a way that 'me' and 'you' become 'we' and 'we' and the activity or artefact become a human achievement rather than a mere product—this is cooperation as working-together. I will designate this working together as *working-together* to emphasise the inseparability of together and of the 'we' and work, as a joint human achievement. One may object and say that this sort of interpretation is utopian and does not reflect the realities of everyday corporate life. This may be true; however, the intention, at this point, is not to reflect on its meaning for our present everyday but rather to 'recover' the lost meaning, the values implied, and the worldview that pervaded the concept since its origin as a particular way of doing. Nevertheless, if these are the values and beliefs implied in cooperation does it make sense to talk of telecooperation? Is there not an inherent contradiction in the idea of working-together at a distance? What is the nature of the together and distance, the separate and yet connected? It is here where I believe the notion of coordination may shed some light.

Coordination stems from the verb *ordinatio* which refer to the process of setting in order, regulating, arranging, and so forth. The root of *ordinatio* is *ordo* which refer to a regular row, line, or series, methodological arrangement, order; also an order or command. An overseer who keeps the order was referred to as an *ordinarius*. It is interesting to note that Latin did not use the prefix 'co-' with ordinate as we do in Modern English. With their understanding of 'co-' this would have been a contradiction. In *ordinatio* arrangements are put in place that regulate. The worldview that is implied in coordinate (as *ordinatio*) is one of two entities, in command of themselves, exchanging arrangements in a way one would expect diplomatic parties to coordinate protocol. They do not interfere with each other, they are not concerned with 'together', as long as a mutually acceptable arrangement *(ordo)* can be made 'coordinating' is succeeding.

My contention now, which I intend to argue in the next section, is that it does not make sense to talk of telecooperation but it may make sense to talk about telecoordination. Clearly this is not simply a matter of playing with words. The social and functional conditions for these two notions will differ dramatically. It is precisely this issue, and confusion, that is at the heart of the current debate about the office of the future and the nature of work in the emerging information society. It is my contention that it is essential that we draw this distinction clearly so that we can articulate where we stand and what may or may not be achievable or desirable.

3. Working-Together

The etymological analysis in the previous section, although rather cumbersome, provides us with a firm basis to explore the conditions and possibilities for working-together. I will now elaborate some of these perspectives. With this in hand the functional and technical requirements, or rather limitations can be explored in the next section.

3.1. Working-together and language

The most important aspect of working-together is language. Language is not only fundamental t communication but is indeed the basis for the co-creation of the social world [24, 31]. To clarify thi point we need to turn to the theory of meaning of Wittgenstein [33]. Wittgenstein argues that wor do not *have* meanings in the same way that a person, or a city, has a name; that is to say that wh we utter their name it is like pointing to the object, person or city[1]. According to Wittgenstei words become meaningful not through being associated with a specific object, action, or event b through having a 'rule-governed' situated use. We can use the analogy of chess here. We understand the knight, not in itself, but in knowing the legitimate moves it is allowed to make i playing the game. We understand what a knight means when we use it to make appropriate move as part of playing chess. Thus, Wittgenstein contends: „Every sign [word] by itself is dead. Wh gives it Life? —In *use* it is alive" [33, #432, my emphasis]; also: „A meaning of a word is a kind o employment of it. For it [the 'rules' for employment] is what we learn when the word i incorporated into our language" [34, #61].

Now one may object and say that clearly the word 'chair' means or refers to, an object of a particular type or description, and of course this is true. However, there are many situations i which this is not true. Take for example the situation where you enter somebody's office and th person points to the empty chair and utter the word „chair?" In this situation the meaning of chai may be said to be 'here is a ehair if you would want to sit down." If one insists on the notion t the meaning of the word is the object it points to, then the appropriate response in this situation m be „I know that is a chair!" which would clearly be impolite. Or imagine someone at a meetin uttering the following: „If I may I would like to address the next question to the chair." Again if one insists on the representational view of meaning then one may wonder why this person wo want to do such a silly thing as addressing a question to a chair. With this in mind, we can imagi what would happen if we could, in principle, have the whole human population to enumerate all the possible situations in which 'chair' is not used merely to point to an object. It is highly probable tha we may end up with an extremely long list. Not only that, but we may, in many cases, have to re to quite elaborate descriptions (explanations) of the particular situations, and subtle conditions, in which a particular use of the word 'chair' would make sense (be appropriate in that specifi

[1] This view is often referred to as the representational view of language (and meaning). In this view the mean of the word is the object, action, and so forth that it refers to.

situation or way of doing). Furthermore, many of these subtle descriptions may vary quite dramatically from one culture to another or organisation to another or in general social group to another. Why may this be so? The reason may be, as Wittgenstein and others would argue, that language is not only a way of communicating (pointing) but first and foremost a way of *doing together*. As people do things together, through language, they innovate in the applying or using of words (rules) in different and novel ways to express local distinctions of import for their efficient or successful interaction. These local rules—or ways of using—introduce potentially infinitely rich and subtle variations of use that may have a very specific and local understanding associated with it. It is these local modifications that allow us to attune language to the infinite complexity of everyday life (of work, play, aesthetics, friendship, parenting, and so forth). In this way we get the emergence of nurse-speak, student-speak, consultant-speak, and many more as extended subtle local languages that emerge, mostly implicitly, as part of using language in that particular way of doing (or form of life as Wittgenstein called it). It is important to note that the emergence of the local language is mostly tacit since the focus of interaction is not to frame a new language as such, it is rather to do well whatever we want to do through our interaction. Often, therefore, when an outsider asks why a word is used in a particular way they may get the response „I am not sure, that is just the way we say (do) it here." This is also why Wittgenstein said that meanings are not agreements of opinions but agreements „in form of life" [33, #241]. Now clearly when we want to interact with another—whatever the purpose of the interaction—we do not at first sit down and agree all the possible definitions or ways of using words. This would be impractical and probably largely impossible since we will mostly only discover that we use it differently *when we do* in a particular situation. Thus, we will have to participate in the form of life, in the doing-together, in order for a common language or way of using particular words to emerge [19].

If Wittgenstein's theory of meaning is relevant, as it seems it is, then it has major implications for cooperation as *working-together*. In order to work-together we must share a form of life. To share a form of life, a language, we must do things together in ways that would allow for very subtle and tacit shifts in ways of using words to emerge. This implies a shared history. Obviously if we just want to briefly do something together that does not require any intricate manoeuvring we finesse our way through the ambiguities of the language (such as when we buy our train ticket). This is however not what is implied in cooperation as discussed above. We must therefore conclude that to cooperate (as working-together) is to share a form of life, a way of doing, that is intimately interwoven with a language, a way of using words. Doing and using sustain and shape each other—

one could say they are two sides of the same coin. This is why language is not merely a matter of communication—as the exchange of information—but is the very essence of shaping a shared social space for meaningful working-together.

5.1. Working-together and the sharing of knowledge

It is generally agreed that the most important asset of an organisation is its organisational knowledge [3, 2, 27, 29]. The *work*, in working-together is nothing other than the co-creation of this important organisational resource, a shared socially significant source of organisational knowledge, a set of locally significant distinctions—a local language. But 'where' is this shared knowledge located? Is it in the technology, in the heads of people, in the information systems, in the organisational structures, and so forth? The best we could do, to answer this question, is to say that it is 'in' each of them, and 'in' all of them together. However, most authors on organisational knowledge such as Nonaka [27], Pentland [29] and Von Krogh [32] agree that the most significant source of organisational knowledge is tacit knowledge [30]. Tacit knowledge is knowledge we can apply *in doing* but may not be able to articulate, when asked to. Hence, we do not know that we know, we only know in the sense that we can apply it or demonstrate how to apply it (the famous example being that of riding a bicycle).

If the most important source of organisational knowledge is tacit, how do we 'get hold of it' to share it in our working-together? In working-together we share it through socialisation, by doing things together. In doing together appropriate ways of doing (and saying) will be explicitly or implicitly acknowledged and as such become part of the shared routines and practices that makes a 'good' consultant, nurse, researcher, and so forth. We could therefore argue that unless the parties really 'do things together' for a reasonable period of time (located in some common time/space dimension) the sharing in the interaction could only be limited to common 'public' language and explicit knowledge (such as the exchange of technology artefacts). Such an exchange of public language and explicit knowledge would amount to coordination (arranging) and not cooperation (working-together). To make this rather theoretical discussion more concrete lets imagine what happens when two people who do not share a form of life get together to have a conversation. We notice that they tend to talk about very general 'public' topics (such as the weather, or politics or sport) using mostly very common 'public' expressions, avoiding particular ways of saying things such as using puns, idioms or play on words. On the other hand when people share a form of life they excel at ploying words, through puns, idioms and play on words, in infinitely subtle ways to seek out intricate meanings not accessible by the general common language. Now if you enter this conversation and ask, „what do you mean by this peculiar way of using this or that expression?" they may attempt an answer but many a time they will say „you really have to be an X (trucker, consultant, teacher, plumber) to understand it." In other words 'if you do not do what we do, then what we say will not make sense even if we try to explain it to you.'

One could respond to the arguments above by positing that if people do already share a form of life, a shared history, then surely they can use electronic mediation to work-together, to telecooperate. There is various ways in which one can react to such a claim. Obviously it is true that there is a level at which existing shared forms of life can function as a source for common understanding. And it they do not overlap entirely we tend to fill the gaps by clever manoeuvring and finessing[2]. We have to do this all the time in everyday life when we interact with those who do not actively share our form of life. However, as we frequently discover in our 'inter-form-of-life' travels, we do not know when we do not know—discovering misunderstanding is very difficult. Now if we act (speak) in a shared involvement, a working-together, such misinterpretation will rapidly manifest itself and will be auto-corrected. On the other hand if working together is electronically mediated the multiplicity of tacit gestures, expressions, and so forth will not be available for such in-action correction. This can only happen in and through socialisation, which means an ongoing active and involved doing together. Having said this, I would argue that such a model of working-together with a shared history that becomes mediated from time to time is not really what the more ardent proponents of telecooperation has in mind—especially the proponents of the virtual organisation [7, 11,14].

3.2 Working-together and power

The whole discussion of language and the sharing of knowledge above deliberately suspended the play of power [10, 12] so as not to obscure the discussion. A social reality where everybody wants to, by default, cooperate and share knowledge is clearly utopian. It assumes a social reality in which

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2 Wittgenstein's notion of *family resemblance* is particularly useful here. He argues that we cannot always give a complete list of characteristics that would define a game as a game. However, we can, because some characteristics overlap, define a game by indicating the other games that share parts of its characteristics. This notion of family resemblance could be the way in which we infer meanings for those gaps that we have to fill as we negotiate different forms of life.

there is a convergence of interests and values. Also, a 'level playing field' in which all are equal participants in a game where everybody will win and nobody will lose. Such a sociology of regulation [6] is in stark contrast with the reality we experience in everyday modern institutions. Our institutions are based on strategic action rather than communicative action [16, 17, 20]. The *Weltanschauung* implied in cooperation is not the values that permeate our everyday institutions. Nevertheless, developers in this field often assumed these values [21]. Does this mean that cooperation as working-together is non-existent? I do not believe this to be the case. However, I would argue that cooperation as working-together is not a default mode of working together. Nevertheless, there seems to be occasions where such cooperation happens. When strategic action is suspended and replaced with communicative action, where we work-together! It is in opportunities such as these that the above discussion on language and the sharing of knowledge becomes relevant. If the values of working-together are not present then cooperation technologies will merely become the very instruments used for strategic action.

4.The Demands and Limits of Telecooperation

I believe it would be fair to say that there is widespread agreement on the ambiguity of empirical findings when it comes to judging the outcomes of computer mediated cooperation cases. There are at least as many cases of 'failure' as there are of 'success', if we can talk of failure or success in this context. In spite of the optimism present in earlier work such as that done by the Arizona group „we are convinced that the use of EMS technology can improve group processes and outcomes in many cases—but effects are contingent on the situation", there always seems to be various reasons why the technology does not match the obvious potential it purport to have [28], Most case studies acknowledge that there is a significant social dimension that needs to be accounted for and which renders measurement and interpretation ambiguous. Beyond rather trivial measurements of usefulness, efficiency and effectiveness it is quite possible to find, in any particular case, as many participants who feel it 'works' as those who feel it does not 'work' [8]. After at least a decade or two of active research on a wide front we still need to see the adoption of this technology beyond the laboratory or some very specific incidents of use. Kraemer and King [22] conclude of group decision support systems; „their use is far below what could be expected given their need and promise." Grudin [15] acknowledges this less than desirable track record of groupware and proposes eight social challenges to be addressed by developers, these related to better design approaches and methods, and more care in implementation. Although I believe these to be very sensible recommendations, I nevertheless believe we still do not have sufficient understanding of the intricacies involved in even the most basic social processes of cooperation in working-together. It seems to me that language is definitely one such process currently assumed or black-boxed.

From the theoretical discussion above one could conclude that there ought not to be a high expectation of success and widespread use of telecooperation by means of cooperative technology. For the following reasons:

- There will always be a significant strategic element present in institutions which would subvert the values needed for cooperation—the cooperative technology may be turned into the very instruments for strategic action.
- In those cases where cooperation as working-together is present the complexity (and subtlety) of language and the sharing of knowledge would make it highly unlikely that telecooperation would be appropriate or even preferred—it may even be actively avoided.

If this is true what about all the groupware in use? Are all the organisations that are using Lotus Notes and other groupware bluffing? I do not think so. However, I do believe they are using the technology for *coordination* rather than *cooperation*. As indicated by the following comment by a user of groupware in a consulting company: „When I am abroad DIESE [the groupware system] replaces verbal conversations. While I am in Paris, I use the system to write a document, say to make an official request, to make public a piece of information I want to send, and for which I want to leave a record. Otherwise, I talk to people. It is a co-ordination tool." [9]. A similar interpretation can be made of the use of GroupSystems technology in the World Bank. The percentage of meetings using the technology for brainstorming and decision-making, which one could argue are activities with a high potential for cooperation, dropped from 12% and 7% in the pilot phase to 1% and 4% respectively in the post-pilot phase [5]. This is obviously not proof. They serve merely to indicate that it is as plausible to argue that the major use of cooperation technology today is not cooperation but coordination.

If the theoretical arguments and the interpretation of the empirical data are plausible, in as much as they argue that cooperative technologies are being used for coordination rather than cooperation, what are the conditions under which cooperative technologies can support working-together? These conditions are by no means obvious. Nevertheless I would attempt to outline some of them. For telecooperation to become feasible there is a need for:

- An environment where the values and *Weltanschauung* are such that working-together is seen as a positive value to be sought after.
- An environment where the local language is well known, widely accepted, and built into the routines of doing the work.
- An environment where knowledge sharing through socialisation is an active and continu process.
- An environment where telecooperation may be used from time to time but where the major source of working-together is a shared form of life that is maintained through freque embodied contact.

Clearly the situations for which these conditions hold are quite limited. Nevertheless it would be my contention that the further one moves away from such an environment, the less cooperativ technologies will be used for cooperation and more for coordination. This may not be bad in itself. It does however suggest that we need to change the way we look at these technologies. Maybe the less ambitious goal of telecoordination is more realistic than the more ambitious, and controversid goal of telecooperation.

5.Conclusion

In the sections above it was argued that the social complexities of cooperation, and the *Weltanschauung* that is implied in it, may make the use of cooperative technologies and notion of telecooperation something we would expect to occur in isolated and very specific environments. We would not expect it to become a widespread phenomenon, as the virtual organisation literat would suggest. The prevailing forces of competition, strategic action and fragmentation would tend to work against such an interpretation. It seems therefore appropriate to suggest that it would be more prudent to focus on telecoordination. A commitment to telecoordination may provide an appropriate focus to enable the technology to play a key role in enabling the transformations neede in our society.

Clearly I have not proved my case, for this to happen much more coherent and convince theoretical arguments are needed as well as more convincing interpretations of a wide range of empirical cases. However, I do believe that I have raised a sufficient level of reasonable doubt for alternative interpretations to be considered. With the limited success of group decision supp system, electronic meeting systems, and groupware in general, it seems that we do indeed need to consider alternative interpretations. We need to push our thinking beyond the laboratory into the messy, complex and political environments of everyday organisational life that continually becomes our barrier.

I believe one of the problems that we face is that we are not able to understand the intricate complexity of the social process, which we are trying to mediate. Simply because we all have become experts at doing it—by the mere fact that we are human beings active in a world. It is not possible to go to a 'place' where we can 'see' the shaping of layer upon layer of complexity that make up seemingly simple human interactions. This is the sort of problem that robotics encountered when they tried to simulate very rudimentary human movements. Whatever we do, we ought to be careful to allow our knowledge and understanding of the social process to develop together with the technology. This has been the attempt of this paper.

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ADAPTIVE QUALITY OF SERVICE IN COLLABORATIVE APPLICATIONS

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Abstract

Current synchronous collaborative applications typically provide multimedia features that require meeting specific Quality of Service (QoS) guarantees. The use of these applications presents particular situations that would be greatly benefited by dynamically adjusting QoS requirements. In this paper, we present a series of mechanisms that will enable groupware applications with the ability to negotiate their QoS levels with the underlying network. Provision is also made to manage QoS in heterogeneous environments by means of a proposed architecture.

1. Introduction

With recent advancements in networking and multimedia, the research field known as CSCW (Computer Supported Cooperative Work) has gained renewed vitality. The current possibility of worldwide collaboration at affordable eosts (*e.g.* using the Web) has fostered the development of collaborative applications that are more interactive every day. Typical groupware environments support not only textual messages, but also multimedia (audio, video and data) delivered in a synchronous fashion. The multimedia nature of these applications impose heavy requirements on the networks over which they run since some of the transmitted media (*e.g.* audio) is very time-sensitive [20]. Therefore, developers face the problem of building applications that provide real-time response, thus raising the need to satisfy certain QoS requirements in possibly heterogeneous environments, due to the distributed reach of the audience [11].

In order to present the problems faced by groupware developers, we will first give a brief survey on how people collaborate by means of currently available synchronous applications. We will

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exemplify typical collaboration scenarios and will point out how these scenarios would be enhanced if there existed some ways to satisfy QoS demands [16]. After this, we will propose an architecture that handles QoS under the scenarios previously shown.

2. Collaborating via Groupware

When technology is introduced in the form of collaborative applications, the way people interacts gets modified, as these applications spawn several interesting scenarios due to different factors involved. For example, there are not only social protocols into play, but also technological ones as well. As pointed out by [7], there are several design issues related to interaction that should be taken into account when designing collaborative applications:

- Place
- Time
- Type of communication
- Social structure of the session
- Social status of participants
- Invocation to participate
- Interaction flow of the session
- Authorship of ideas
- Styles of accomplishing a larger task
- Access to a public area
- Type of contribution

Aside from these design issues, one thing that also affects the way people interact is the infrastructure [2]. The network may present different distribution modes like multicasting, broadcasting, point-to-point, multipoint, etc. It is also possible that the networking environment is totally heterogeneous and that there is a complex mix of network technologies and terminal equipment with extremely different capabilities. This may force some participants to interact in a very humble way while others have powerful tools for richer interactions.

2.1. Typical scenarios

Aiming to understand the issues that arise when people is enabled to collaborate using technology, and as a matter of exemplifying our ideas, we will present several scenarios that are typical when using groupware tools. We will refer to several applications that are currently available and that are clear examples of the situations under discussion.

2.1.1. Virtual classroom

Several systems currently into use take the classroom, or at least a classroom-like presentation as their paradigm. These include commercially available systems such as Itinerary by Contig

Software [6] as well as research projects, such as EDUBA [17] or academic systems as WP [1], which have been successfully used for this purpose.

In one such environment, a presenter coordinates the presentation by means of technological or social protocols. She will be able to present different slides, changing from one to another as the presentation progresses (at the pace that she feels necessary) and the audience will see this progression without being able to interfere with it. In most systems, there's unidirectional audio/video from the presenter to the audience, although there is often the need to enable bi-directional audio/video links between the presenter and one or more participants. This is the case when an audience member asks a question that the presenter will respond to, and the audio/video feed from both interlocutors to the rest of the audience, so they can be aware of what's going on. In this situation, bandwidth and other QoS parameters have to be negotiated for a new connection, and also for the unidirectional ones that should be opened for the other audience members. When the question/answer session ends, all that the audience will need is go back to just an audio/video feed from the presenter. This feed could be set at a higher QoS level, since all other links are closed.

2.1.2. Support for casual interactions

In many cases, very productive work is the outcome of non-planned meetings, such as a casual interaction at a cafeteria. [12] gives an example of non-planned collaboration. An environment that supports casual interactions has been tested at CICESE [5] where two laboratories in different buildings have a permanent bi-directional audio/video link, so people can at any moment look into the other lab and see if a particular person is currently there. A dedicated computer is set up at each location and placed in strategic locations, so if someone spots another person with whom he wishes to interact, then he will try to get his attention via pre-defined audio signals. Once the target person notices this, she will be able to go to the computer and use the groupware tools that are installed, so collaboration can take place.

Although the environment has been tested with a satisfactory degree of success there are some details that are planned for its enhancement. For example, the bandwidth used for the permanent audio/video link could be optimized. We envision a scenario where a low quality, low bandwidth connection is established just for the sake of awareness, and when an explicit request for interaction is replied, a better level of service (*e.g.* more bandwidth) is dynamically allocated. The connection would go back to its low service level when the actual collaboration ends. A mechanism that deals with QoS issues is therefore needed.

2.1.3. Brainstorming sessions

Recently, several commercial tools like CU-SeeMe by White Pine Software [21], NetMeeting by Microsoft [15], Live200 by PictureTel [18], and many research projects such as LEVERAGE [14], are making desktop collaboration a reality. In this kind of environments, no "formal" presentations are usually conducted and there isn't a person with the role of presenter, as is the case with the virtual classroom environment previously described. Instead, collaboration is carried out resembling a brainstorming session, where everyone is allowed to discuss his/her ideas, and where usually there are only social protocols indicating when it is appropriate to make an intervention.

A typical setting would have either point-to-multipoint, or multicast connections, and the participants would be able to visualize all others through several windows displaying the incoming video. An interesting case would arise when the environment is truly heterogeneous and the participants have different media-playing capabilities, links with different bandwidths, etc. In such case, some sort of mechanism should be provided to adapt the service level according to each participant's capabilities.

Now that some typical scenarios have been described, and that the need for implementing mechanisms for supporting QoS level of service reconfiguration has been pointed out, we will proceed to propose an architecture that addresses QoS management.

3. A QoS Architecture

As we have described, there is a need for various levels of QoS in groupware. This need is not constant, and in some scenarios the QoS has to be adapted to support different modes of interaction between the participants. This paper proposes an architecture that approaches the problem in a generic way, trying to find a solution that is appropriate for different and heterogeneous scenarios. We will analyze the infrastructure needed to provide QoS first, and propose an architecture and a service to manage QoS.

3.1. QoS Infrastructure

To satisfy the QoS requirements of the applications over various heterogeneous networks, there needs to be an adequate infrastructure that supports the provision of a service level. We distinguish three different levels of infrastructure:

- *QoS Network infrastructure*. The networks have to provide some facilities that allow allocating the adequate resources required to support and deliver a service level requested by a application. The resources include link bandwidth, switching capacity and routing capacity. RSVP [3] and ATM [9, 19] are both placed at this level.

- *Session infrastructure.* This level supports the establishment and control of a QoS-management session between the different participants in a synchronous multimedia conference. The services provided by this session infrastructure permit to create, join, abandon or destroy a session in which there is multipoint communication between the participant nodes. This session infrastructure can be provided by the ITU-T T.120 series of Recommendations [13] or by the combination of some reliable multicast protocol (e.g. RMP, MTP/SO) and the session description protocol SDP [10].

- *QoS Management infrastructure.* This level uses the two previous ones to establish a QoS-management session between the different nodes participating in the provision of a service level. User terminals, switches, links, routers and servers are grouped in different QoS management domains, under the control of a QoS Broker.

This paper focuses on this last level. In the following sections, we will detail its architecture and functionality.

3.2 QoS Management Infrastructure

The management of the QoS is carried out by adopting a partially distributed architecture. The different network elements (user terminals, switches, routers, servers and links) are grouped in different QoS management domains. In each domain the following three functional elements are distinguished;

- *QoS Brokers.* A QoS Broker coordinates the resources within its domain and is responsible for arbitrating access to those resources. There are mechanisms to communicate the different capabilities of each node to the QoS Broker and the QoS Broker will act as the controller of the nodes under its zone. The Broker will maintain a database with the information about the capabilities of the different nodes in its domain. QoS Brokers of different domains will talk to each other to provide a service.•

- *User terminals.* They will request the different services to its domain QoS Broker, acting as clients of the Brokers. Different terminals will have different multimedia and networking capabilities. They will have to provide and update the information about its capabilities to the QoS Broker.

- *Quality Adapters.* A special type of entity under the control of the Brokers will be the Quali Adapters, that provide filtering and transcoding capabilities in order to adapt the QoS level fo different networks or different types of terminal. The Quality Adapters will act as servers for t QoS Broker in its domain. They will have to provide and update the information about it capabilities to the QoS Broker. A domain may have zero, one or many QoS Adapters. Noti this functionality is different from that of the routers in RSVP, which is located in the Qo Network infrastructure.

In order to carry on with its coordination tasks, QoS Brokers need to communicate with oth domain's Brokers. The protocol needed for inter-broker communication has the following basi primitives:

- `Reserve_Request (destination, flowid, media_desc, flowspec, QoS_level);` thi primitive is used when broker A needs to tell broker B that a terminal in domain A wishes to establish communication with a terminal in domain B. For this purpose the destinati terminal's address should be specified, as well as a flow identifier, a media descriptor (e.g MPEG, etc), a flow specification, which is a quantitative specification of QoS (e.g. delay, jitte bandwidth, etc.), and the QoS level, which is a qualitative specification of QoS (e.g. guarante predictive, or best-effort).

- `Reserve_Accept (flowid, accept, media_desc, flowspec, QoS_level);` this will be broker B's response to Reserve_Request issued by broker A. For the specified `flowid` th parameter `accept` will indicate if the request was accepted or not. If it was accepted, it may be the case that it is accepted exactly as the request indicated, or either with modifications in th `media_desc`, `flowspec` or `Qos_level` parameters. The decision of accepting the request as it was issued, or with modification, will be taken by broker B based in the knowledge about the receiver terminal capabilities and the quality adapters in its domain. This knowledge will resi in a local database.

- `Reserve_Confirmation (flowid, accept);` after receiving a `Reserve_Accept` indicatio broker A will respond with this primitive indicating if the offer made for accepting `flowid` is appropriate or not, as indicated in parameter `accept`.

- `Reserve_Distand (flowid);` it is used when a reservation is no longer needed.

The use of these primitives has been analyzed for the different scenarios presented in the paper. A example describing one of these scenarios how it is handled by our proposed architecture will be later presented.

3.3. QoS Management Service

In order to provide an adequate service level to the user terminals, the abstraction used is the *real time multipoint channel*. A multipoint channel is a communication path that transports a media stream from a source to one or more destinations. It identifies the infrastructure required and uses the QoS Management infrastructure services and the QoS Network infrastructure services to open the needed logical channels and configure intermediate nodes to process and adapt the media stream is necessary.

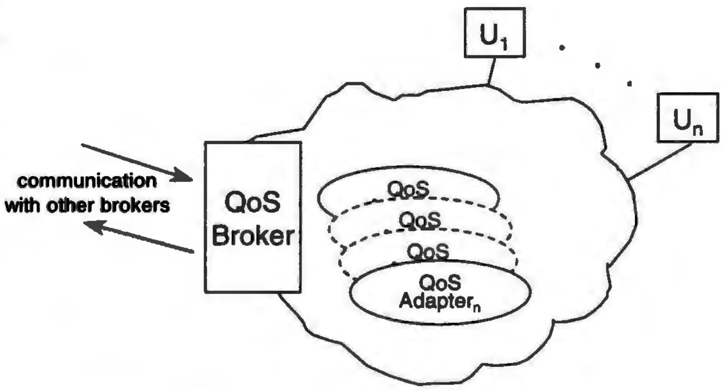

Figure 1: Elements of a domain in the QoS architecture

The users will characterize the requirements of the multipoint channel by specifying the media type (e.g. audio), the encoding format (e.g. G.711), and any other format specific parameters. QoS characteristics can also be expressed explicitly in generic terms (e.g. bandwidth, latency and jitter). When a new channel is needed, the QoS specification of the channel will be sent to the domain QoS Broker. The QoS Broker in the sender domain will then start the procedures to make the reservations needed, and will talk to other domains Brokers to consult if the QoS can be obtained in every participant domain. Thus, the negotiation is initiated by the QoS Broker in the sender domain, and this QoS Broker will be responsible for deciding if a channel can be created with the service level required by the application. Another approach is to centralize the decisions about how to accomplish a QoS in a Top Broker, designated for the session.

The application will also require a way to modify the QoS of a multipoint channel while it is still in use. The request to the broker will include a new specification of the QoS for a multipoint channel, and the Broker will then start the procedures to make the modifications needed to obtain the new service level.

4. The Architecture in Action

In section 2.1 we described some typical scenarios that arise when using several kinds of applications; we also presented some motivations for enhancing these scenarios through QoS level (re)negotiation. Now, we will proceed to describe how our proposed architecture would deal with supporting these enhanced scenarios.

In the *virtual classroom scenario* (section 2.1.1) we had a presenter and several members of the audience. Such situation is represented in *Figure 2*. The normal situation during the presentation would be to have the audience receiving audio and video coming from the presenter.

Now, let's suppose that at some point during the presentation, audience member number i in domain j, U_{ji}, wishes to ask a question (he may click on a button). What is needed here is that the presenter and U_{ji} are able to establish bi-directional communication, and that all audience members receive audio and (possibly) video from u_{ji} so they can be aware of what is being discussed. For this purposes, u_{ji} will request his local broker QB_j the creation of a channel for audio and another for video, so QB_j will check if the reservation is possible within its domain and then will issue a `Reserve_Request` to all other brokers.

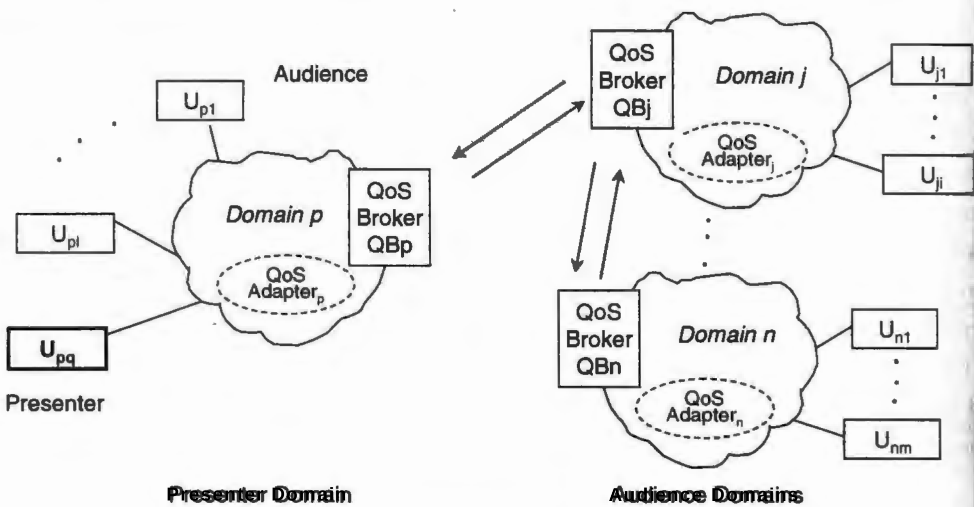

Figure 2: Interactions in a virtual classroom scenario

Assuming a heterogeneous environment, there will be terminals with different capabilities, some of which will not be able to receive audio, video, or both. If no users are able to receive video at domain M the local broker QB_m will know about it and will answer with a `Reserve_Accept` setting the parameter accept to `false`, thus denying the reservation for the video. If an terminal, say u_{xy}, can not receive video in the format specified by the `Reserve_Request`, then QB_i can accept the reservation but use a quality adapter (if there's one in its domain) to make the conversion to the appropriate format.

Once the originating broker QBj has received all reservations acceptances or denials from the rest of the brokers, two situations can be possible:

1. QBj will decide to send the flow to only those domains who accepted, and will send a `Reserve_Confirmation` with parameter `accept` set to `true` to the corresponding brokers; those who denied the reservation will not receive the flow.

2. QBj will decide to renegotiate the reservation so all the domains can to receive the flow. This will imply sending a new `Reserve_Request` with different parameters that fit the capabilities of the receivers. The number of renegotiations has to be set to some appropriate limit, so if after this limit no agreement has been made, QBj will answer with a `Reserve_Confirmation` with parameter `accept` set to `false`.

When the open channels are no longer required, the originating broker QBj will send a `Reserve_Disband` to all the involved brokers to free the associated resources.

In the scenario that gives *support for casual interactions* there is ideally a constant low-quality, low-bandwidth audio/video connection between two labs, just so members of each lab can be aware of who's at the other lab. This connection can be normally handled by a best-effort service, so there would not be a need to establish QoS requirements from the network. However, to support the collaboration, there is a need for good quality audio and video, and then a reservation is needed. The negotiation would be very similar to the example above, but without the need to support multiple receivers.

Under the *brainstorming session* scenario we can suppose that users are communicating via point-to-multipoint audio/video connections. We use this scenario to exemplify the case of a heterogeneous scenario where a user wants to send data to another and the intended receiver is not able to handle the data format. In such a case, our architecture would allow two possibilities. The first one is that the receiving broker uses a quality adapter in its domain to convert the data into the adequate format (for example a MPEG video into a H.261 video). The other option is that the originating broker uses a quality adapter in its domain to do the transcoding.

5. Conclusions and Future Work

The increasing complexity of today's collaborative applications, specially synchronous ones, present software developers with the burden of dealing not only with application-level details (e.g. the user interface), but also with details related to the network infrastructure and the platform where the applications will ultimately run, which get more complicated in heterogeneous environments. We have presented a high level architecture to support QoS provision to applications used in collaborative environments with synchronous interactions, which hopefully could help developers by providing a layer that hides these network-oriented details. We use a partially distributed approach, whose advantage is mainly the reduction of the overhead of maintaining consistency between multiple nodes, while avoiding bottlenecks introduced by an excessively centralised solution [4].

Some topics have not been addressed in the paper and are subject of further research. The session infrastructure is the basis for the communication between QoS brokers, QoS adapters and terminals requesting services. How and when the sessions are established needs to be studied. In addition, session management has to provide a directory service to resolve the address of the QoS broker for a domain, and possibly the name of the domain for a terminal. The use of RSVP as a provider of the network infrastructure service used by the QoS Management infrastructure defined in this paper is a subject of further research.

6. Acknowledgements

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DISTRIBUTED WORKFLOW EXECUTION BASED ON FRAGMENTATION OF PETRI NETS

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Abstract

The development towards distributed business processes and the increasing demand to support business processes by information systems induce the necessity of distributed workflow management systems. This paper presents an approach for the distributed execution of workflows based on the fragmentation of high-level Petri nets. Petri nets combine the graphical representation of workflows and a formal foundation. A method for the fragmentation of Petri nets is presented which fulfills formal requirements concerning the workflow behavior.

1 Introduction

The globalization of companies, flexibilization of organizational structures, cooperation between companies, mobile computing and the development towards distributed business processes require the application of distributed information system technologies. Distributed database management systems, workflow management systems, and groupware technology as for example e-mail, video conferencing, or application sharing enable the distributed execution of business processes and support telecooperation. Complex centralized workflows have to be partitioned due to

- the geographical distribution of organizational units as for example in satellite working centers,
- the distribution of data,
- the complexity of the workflow, and
- performance enhancement by parallel execution.

In the best case the workflow fragments should be stored and executed at the site where the responsible organizational unit and the required data are located [3]. This task requires a distributed workflow management system on the execution level and on the design level methods for the fragmentation of centralized workflows. In this paper, we present an approach for the distribution of workflows based on the fragmentation of high-level Petri nets such as predicate/transition nets. Data fragmentation and replication concepts for relational databases are modified and extended to process fragmentation and replication. Predicate/transition nets [6] provide a natural extension for the relational data model concerning the dynamic behavior of the relations. They combine the graphical workflow representation and a formal foundation [1, 5, 9]. Hence, the Petri net model can be directly executed by a workflow management system.

In the next section, we survey some basic concepts from the area of distributed database systems and predicate/transition nets. In Section 3 we discuss the fragmentation of workflows. The requirements concerning the fragmentation of predicate/transition nets are explained and fragmentation methods are proposed. In Section 4 we compare our approach to related work and conclude with a brief outlook on future work.

2 Existing concepts

2.1 Data Distribution

Distributed database systems allow the management of geographically distributed data, stored at different sites of a computer network. The database user can work with the database as if it were a centralized system: the distribution of relations or parts of relations called fragments is transparent to the user. Fragments are either disjoint subsets of the tuples i.e. different rows of the table (horizontal fragmentation) or selected attribute values for all tuples of a relation i.e. different columns of the table (vertical fragmentation). For a simple example see Figure 1. An iterated fragmentation is possible, whereby horizontal and vertical fragmentation can be mixed up. The relations have to be fragmented in a way such that the original relation can be reconstructed [13]. Redundancies by overlapping data have to be omitted unless they are essential for the composition of the fragments (like primary key attributes in vertical fragments). The allocation of the fragments depends for instance on the availability and the storage costs of the sites, the communication costs, and the data retrieval and update frequencies. To ensure quick and reliable data access, the fragments can be replicated to several sites.

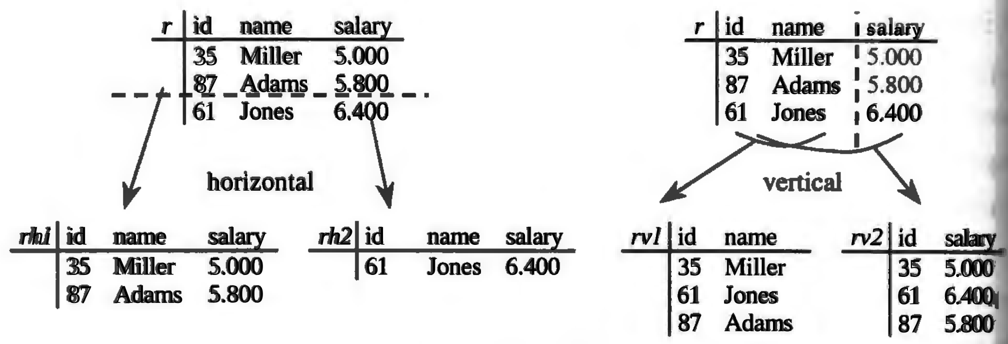


Figure 1: Fragmentation of a relation

On the one hand, the distribution of a database requires additional facilities of the datab[ase] management system like transaction processing based on the two-phase-commit protocol [7, 10]. On the other hand, each site can be administrated autonomously and perform local query processing, what enables a high degree of concurrency. A detailed introduction into the area of distributed databases can be found for example in [10, 13].

2.2 Petri nets

For the modeling of business processes several more or less formal description languages have been proposed. In contrast to other languages, Petri nets [2, 11] combine the advantages of the graphic representation of processes with a formal definition. This allows on the one hand the analysis and validation [4] of business processes and on the other hand the visualization of processes. High-level Petri nets such as predicate/transition nets [6, 9] integrate behavior- and object-related aspects of workflows.

A predicate/transition net (PrT-net) is a Petri net where the places (predicates) represent relation schemes. The marking of the net assigns to each place a relation according to the respective relation scheme. A transition represents a class of operations on the relations in the adjacent places. Transitions and predicates are connected by directed arcs. A transition is enabled for a given marking (that means it may occur) if

- certain tuples exist in the relations of the input predicates,
- certain tuples do not yet exist in the relations of the output predicates,
- and the (optional) logical expression of the transition is true.

When a transition occurs, the respective tuples are removed from its input places and inserted into its output places according to the arc inscriptions. Figure 2 shows an example for a PrT-net. If the transition 'assigning order number' occurs, the current order number is assigned to an order entry and the complete order is inserted into the relation 'order'. The respective order entry is deleted, and the next available order number is written into the relation counter.

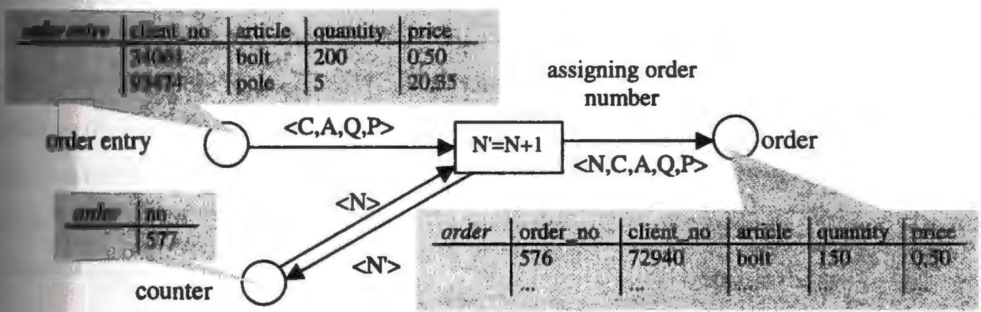


Figure 2: Activity 'assigning order number'

PrT-nets allow to represent sequential, concurrent and alternative processes. Furthermore, it is possible to model conflicts such as resource conflicts or the competition for a document. A more complex example is presented in the next section.

2.3 Example

The workflow model in Figure 3 describes the computer supported business process 'order execution' of a mail-order-house. The workflow execution is initiated by the arrival of an order. The required information about an order is the order number, the client number, the article with the price and the ordered quantity. If the order amount (quantity * price) is 1000 $ or less, no solvency check is necessary. The workflow management system automatically executes the activity 'low amount'. Otherwise, the solvency must be checked by the finance department. If the result of the check is negative, the order is refused. If the solvency check turns out to be positive, then the order is accepted. For an accepted order, the article is taken from the stock and packed together with the invoice. If the amount of the article in the stock is smaller than the ordered amount, the article is added to a list of missing items. Finally, the packages are delivered by the mailing department.

3 Fragmentation of workflows

The fragmentation of a workflow has an important influence on the execution performance, especially on the communication between the cooperating workflow management systems. Thus, the fragmentation should be anticipated during the workflow design. Formal requirements on the workflow fragments are necessary in order to avoid inconsistencies and to ensure that the distributed workflow has the same behavior like the original workflow.

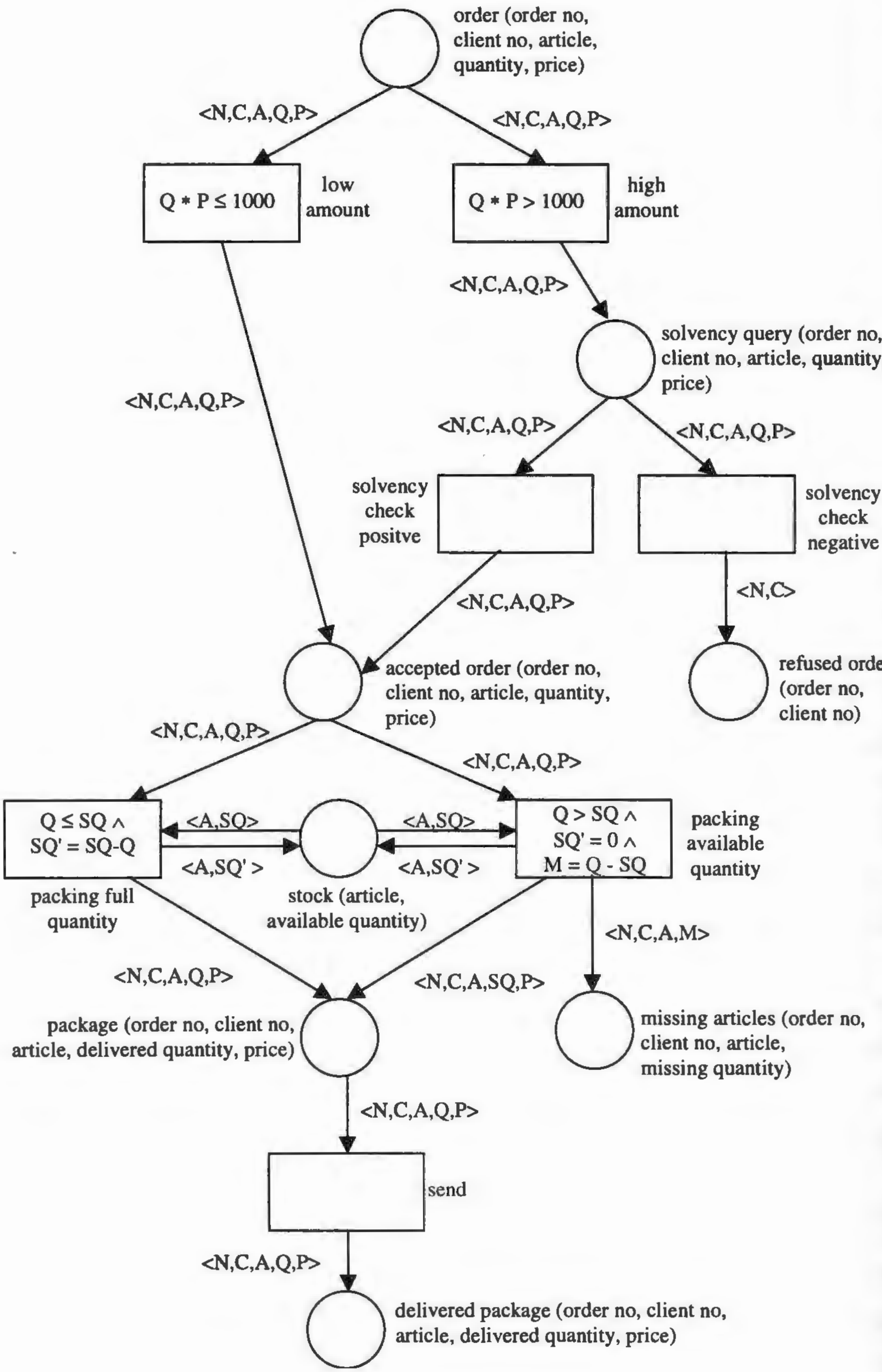


Figure 3: PrT-net 'order execution'

3.1 Process patterns

Within business process models recurring process patterns can be recognized. The sequence of two activities, e.g., is a simple process pattern. The first activity can be executed independently of the next activity. Conversely, the results of the first activity are essential for the execution of the next activity. A Petri net for a sequential process can be seen in Figure 4 (a). Two activities are alternatives (Figure 4 (b)) if they compete for the same resources, i.e. the respective transitions have at least one common input or output place. Figure 4 (c) shows two concurrent activities which can be executed independently. Finally, two activities can depend on one another (Figure 4 (d)) which corresponds to cyclic processes.

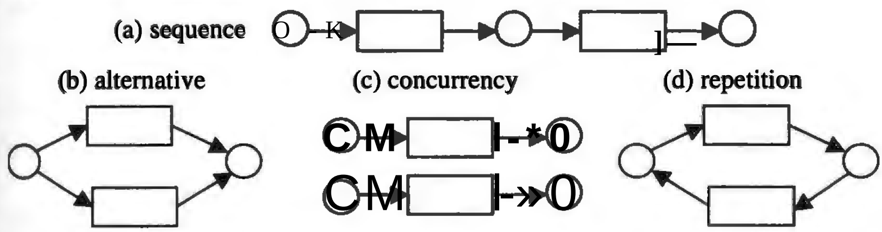


Figure 4: Process patterns

The different process patterns consisting of only two activities can be easily extended to processes with more than two activities. The recognition of such patterns represents a basis for a suitable fragmentation of workflows.

3.2 Requirements

Workflows should not be arbitrarily fragmented. In the first place, the fragmentation of the corresponding Petri net has to satisfy some formal conditions which can be derived from the requirements on the fragmentation of databases [10]. The fragmentation has to be complete, minimal, and disjoint. For a complete fragmentation, each place, transition, and arc of the original net is part of (at least) one of the fragments. The fragmentation is called minimal if no fragment contains a place, transition, or arc that is not part of the original net. A complete and minimal fragmentation is necessary to ensure the lossless reconstruction of the original net. On the workflow level the reconstruction property ensures that the process is not changed by fragmentation: neither predicates nor transitions have been added and the flow has not been changed. A disjoint fragmentation is a decomposition into fragments without overlapping parts – unless overlapping parts are needed for the reconstruction of the original net. Figure 5 shows an example of a fragmentation, which is not disjoint.

The overlapping fragments 1 and 2 in Figure 5 contain the same part of the process: the gray pl and transitions. Yet, it is not clear how fragment 1 and fragment 2 communicate and at which poi the decision is made whether the transition T_3 occurs in fragment 1 or in fragment 2. To avoid thi ambiguity, we only allow to model replication of processes by copying whole fragments. Th subnet containing P_2, T_3, and P_3 has to be a fragment of its own in order to be replicated.

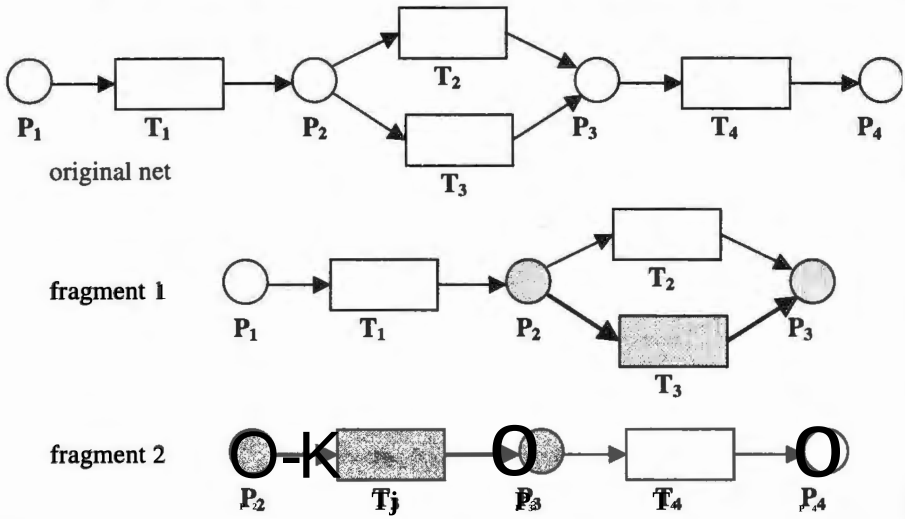


Figure 5: Non disjoint fragmentation

Supplementary requirements with respect to the fragmentation of workflows concern the performance of the workflow execution. Reasons for fragmentation are for example

- the reduction of cost and time of the communication with the database by adapting th fragmentation to the distribution of data,
- adapting the fragmentation to the organizational structure and resources like hum resources, external applications etc., or
- the hardware restriction of capacity and performance tuning by distributing the workflow.

On the other hand, distributed workflow execution implies cost for the communication between th fragments. Therefore, the cost saving by workflow distribution has to be considered in relation to the additional communication cost. A decomposition into many fragments can even turn out to be disadvantageous.

3.3 Fragmentation of PrT-nets

In this section, we describe the fragmentation of PrT-nets. Due to space limitations we omit the formal definitions and concentrate on an informal description of the fragmentation.

3.3.1 Methods of fragmentation

We decompose PrT-nets by splitting the predicates. Predicates are split by duplicating them and assigning the copies to the respective fragments. In the following, we call these copies interface predicates. The marking of the predicate in the original net can be assigned to the corresponding interface predicates in two ways:

Replication: The relation (marking) is replicated to those nodes where workflow fragments that contain the corresponding interface predicates are stored. Because the occurrence of an adjacent transition represents an operation on only one copy of the replicated relation the update of the other copies has to be synchronized. Although replica control is mainly a task of the database management system, the workflow management system has to handle concurrency of transitions concerning different copies of one relation. Due to data replication, the enabling of a transition can be tested locally, i.e. without communication with other fragments.

Fragmentation: The relation can be fragmented horizontally. At one instance each tuple of the original marking is part of the marking of exactly one interface predicate. A tuple can be sent from one fragment to another (for example data resulting from one process can initiate another process). In this case, the rule for the enabling of transitions which are adjacent to an interface relation has to be modified: We do not test if a tuple is part of the whole relation of the predicate, but only if the local fragment contains this tuple. Therefore, tuple migration only presumes communication between the fragments based on a simple data transmission protocol. In Figure 6 the net is fragmented twice. The relation corresponding to the predicate P_2 is also fragmented, but transition T_4 cannot occur unless at least one tuple is sent from fragment 1 to fragment 3.

The decision whether relations of interface predicates are replicated or fragmented depends on the workflow itself: fragmentation is more adequate if tasks are being delegated, whereas replication is suitable whenever tasks can be chosen from a 'to-do-list'.

3.3.2 Horizontal, vertical and diagonal fragmentation

In the first place, we explain the notion of dependency between two fragments. Suppose a PrT-net being decomposed into fragments $F_1,\ldots,F_n$. Then we say *fragment F_j depends on fragment F_i* if both fragments contain a predicate s for which the following holds: s is an output predicate of at least one transition of fragment F_i and an input predicate of at least one transition of fragment F_j. That means, we can observe a data flow from fragment F_j to fragment F_j in the original net. Using this definiti[on] we are able to distinguish between the following fragmentation methods.

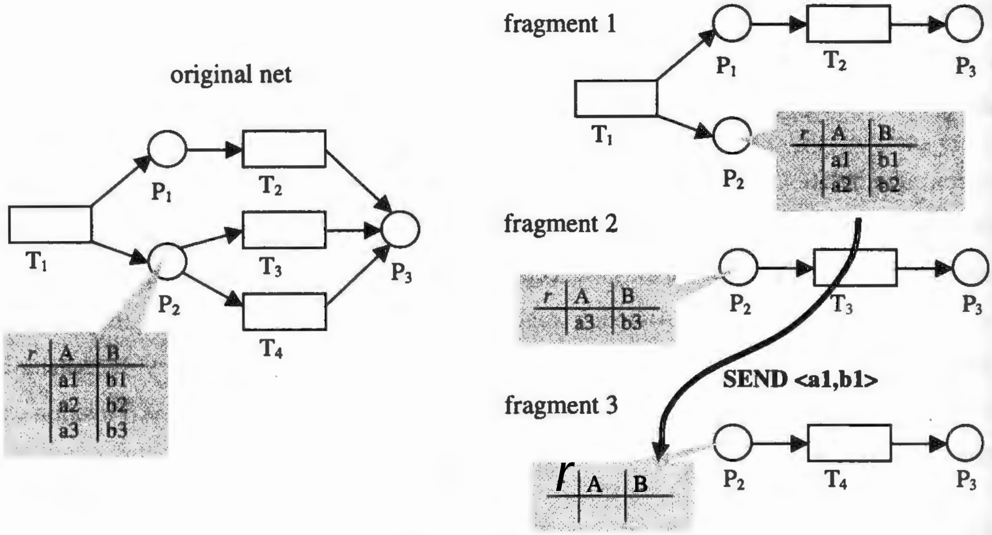


Figure 6: Migration of tuples

Vertical fragmentation: A net is decomposed into two vertical fragments if one fragment depe[nds] on the other one, but a dependency does not exists in the other direction. We say the vertic[al] fragmentation is orthogonal if the intersection of the fragments contains exactly one predicat[e]. Examples for a vertical and an orthogonal fragmentation are shown in Figure 7. A vertic[al] (orthogonal) fragmentation into three or more fragments can be reached by iterated decompositio[n] of the fragments. The vertical fragmentation can be applied especially for sequential workflows.

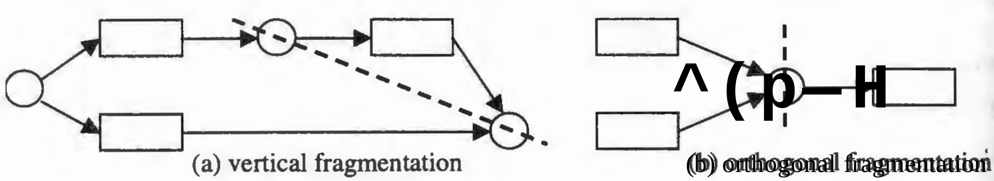
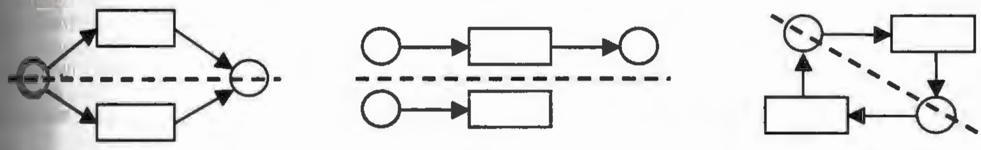


Figure 7: Vertical fragmentation

Horizontal fragmentation: A Petri net is decomposed into two horizontal fragments, if no fragme[nt] depends on the other fragment. Alternative or concurrent processes can be fragmented horizont[ally] like in Figure 8 (a) and (b). For concurrent processes the fragments have no interface predicate [in] common. Iterative application of horizontal fragmentation is also allowed.



(a) alternative process (b) concurrent process (c) repetition

Figure 8; Methods of fragmentation

Diagonal fragmentation: If two fragments depend on one another we call the net diagonally fragmented. A simple example is shown in Figure 8 (c) for a repetitive process. The three fragmentation methods can also be mixed up.

3.3.3 Example revisited

In this section, we consider the example of Section 2.3 and first decompose the net into three vertical fragments. Afterwards, fragment 1 is decomposed into the horizontal fragments 1a and 1b (see Figure 9). The execution of the workflow fragment 1a is due to the workflow management system. The workflow fragment 1b must be executed at the finance department. Fragment 2 describes the inventory management, and finally fragment 3 concerns the mailing department.

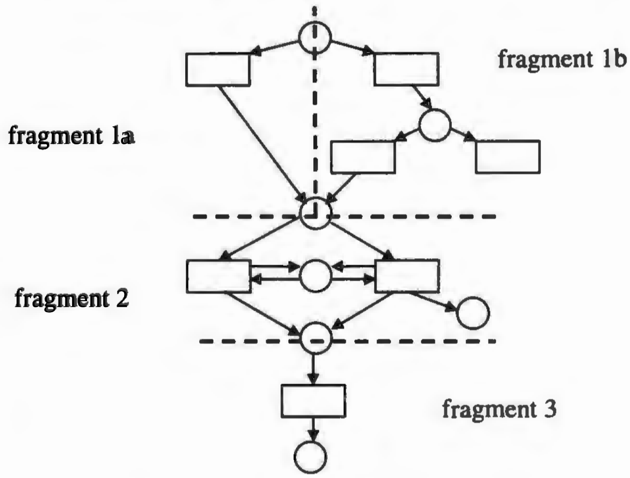


Figure 9: Fragmentation of 'order execution'

3.4 Architectures

For the execution of centralized workflows, a single workflow engine serves as an interpreter for the PrT-net model of the workflow. If the workflows are distributed, the workflow management system can be implemented due to different architectures. First, the distributed workflow can be executed by a central workflow engine that is installed at one of the sites (client/server architect Second, several workflow engines can be used instead of a single central workflow eng (distributed architecture). The workflow fragments are either executed by the local work engines at the corresponding sites with one of the sites being the workflow coordinator or by loca autonomous workflow engines without a central coordinator.

The allocation of the workflow fragments can be fixed or variable. In the first case, the fragme are stored at the sites where they are executed. In the latter case, fragments can be sent to t execution site on demand. Whether a workflow engine is installed at a specific site or sent to a site on demand (together with the workflow fragment) depends for example on the size of the workflow engine in relation to the size of the workflow fragments, the average number of workfl fragments to be executed at the site, the maintenance and update cost of the workflow engine, an the flexibility of the workflow fragment allocation. The sending of the workflow engine (whic e.g., implemented as a JAVA applet) to the execution sites allows for example to add spontane new execution sites to the system. Moreover, the workflow management system automatic works with the most recent version of the workflow engine. Though, if the migration of th workflow engine causes too much network traffic, the performance can be improved by insta the workflow engine locally.

4 Related work

4.1 State and activity charts

The workflow management system MENTOR [8] uses state and activity charts as modelin language for workflows. Activity charts specify the data flow between activities whereas sta charts describe the control flow. A method for the fragmentation of workflows is based on t partitioning of activity charts and state charts. The correctness of the partitioning can be verif due to the formal foundation of the modeling language and the fragmentation method.

4.2 Communicative and cooperative nets

For communicative nets [12], the object-oriented paradigm is applied to PrT-nets. Yet, the mai purpose of this approach is not the decomposition of large PrT-nets. In communicative ne fragments correspond to objects of different object types which interact by sending messages an encapsulate their behavior. The interface between the objects are arcs: one object contains transition which sends tuples to a so-called accept-place of another object. The enabling conditio restricted to the object. Yet, it is not clear how to treat 'message sending transitions" with more than one output predicate. Cooperative nets differ from communicative nets only by the interaction mode, a client-server protocol.

5 Outlook

In this paper, we have presented concepts for the fragmentation of Petri net-based workflows. PrT-nets can be fragmented horizontally, vertically and diagonally, and the fragmentation fulfills the necessary requirements like completeness, minimality and disjointness. Due to space limitations we had to omit several aspects. For example, protocols for the synchronization of replicated relations have to be adapted to the synchronization of replicated workflow fragments. Further, criteria for the allocation of workflow fragments depending on the allocation of data and resources must be found. Another relevant issue concerns the optimization of the fragmentation. For this purpose, the notions of size and complexity of a workflow and its Petri net model have to be examined in detail. Finally, recovery mechanisms must be found to support a failure-tolerant workflow execution.

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Does GSS Favor Group Task or Socio-emotional Interaction

—An Empirical Investigation

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ABSTRACT

In general, group task and socio-emotional interactions simultaneously exist in group process, an these two types of interactions are important to group's functioning and quality performance. Do GSS support both types of interactions, or does it favor one type over another? And why? Th research examines these important issues which have not been specifically studied in GSS literat Task and socio-emotional interactions are studied from the perspective of group influence. Resea results report that GSS can significantly influence group interaction process and it appeares to fa group task interactions but not socio-emotional interactions.

1. INTRODUCTION

Research literature shows that a GSS tends to increase the group task performance of decisi quality but fails to enhance or even decreases group satisfaction (e.g., [3]). The theoretical reaso for this issue have not been fully known. Most prior GSS research focused on *group outco* largely neglecting *group interaction process* [16]. But group interaction process is central to a grou [15]. Research on group outcomes can indicate *what* GSS can or cannot do for a group but might n fully explain *why and how* GSS can or cannot do for this group. Group process study migh therefore provide additional insights on why GSS can increase decision quality but not decisi satisfaction. Hence, more research is still needed to study group interaction process that has bee regarded as a black box in most prior GSS research (e.g., [26]).

Further, group problem solvings or decision makings have been frequently studied by most pri GSS research, while research on other important group issues such as group social behaviors ha been sparse. Hence, GSS researchers have been appealed to pay more attentions to perspectiv from other disciplines like social psychology (e.g., [16]). Literature review on social psycho shows that two types of group interactions generally exist in *group process*, i.e., task and soci emotional interactions that co-exist and are equally important to a group (e.g., [1], [4]). More rec research [19] also indicated that even in task-oriented computer system design meetings, only 40%

of the meeting time was spent in task-focused discussions and interactions. After realizing the importance of *group interaction process* and the *two kind of interactions* to a group, this study therefore specifically addresses the following two research questions: Does GSS support task interactions, or socio-emotional interactions, or both in *group interaction process*? And why?

Section 2 and 3 of this paper briefly review related prior research, derive a conceptual research model for this study, and formulate hypotheses. Section 4 discusses research methodology. Research results are reported in section 5. Section 6 presents discussion and implications of the research findings.

2 LITERATURE REVIEW ON SOCIAL PSYCHOLOGY

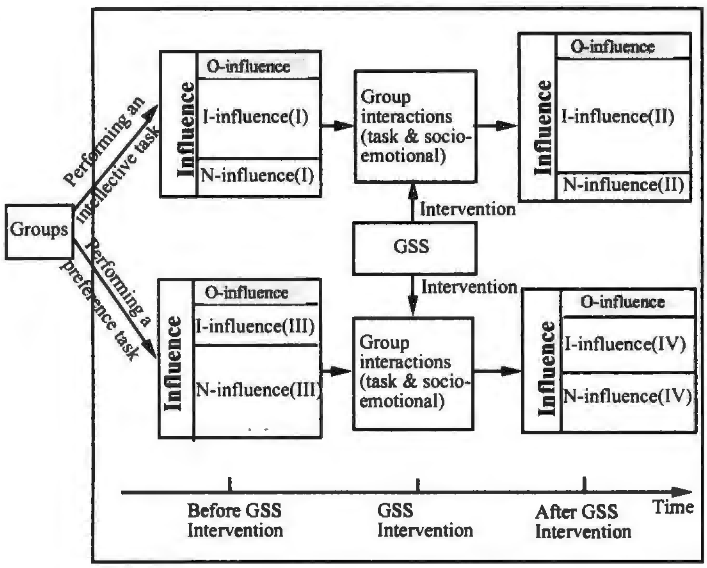
Group can be viewed as an interaction system that mainly consists of two type of interactions: task and socio-emotional interactions [1]. *Task interactions* of a group are directly relevant to the group task and are involved in asking/giving information, suggestion, direction, and possible ways of action; whereas *socio-emotional interactions* are directly relevant to the relations between group members or internal needs (or preferences) of members [1]. In group process, members interact with each other and thus naturally exert some form of influences on one another (e.g., [11]). As a result, group interactions can be studied from *influence perspective*. In general, two form of influences have been identified and largely studied in social psychology literature, i.e., informational and normative influence. *Informational influence* is based on the acceptance of information from others as the evidence about reality and *normative influence* is based on the desire to conform to the expectations of other group members [8]. The main factors favoring the two influences under various conditions can be summarized in Table 1. Therefore, *from a group influence perspective*, task interactions can be reflected in informational influence while socio-emotional interactions can be reflected in normative influence.

Table 1 Informational and Normative Influence

Conditions	*Informational Influence*	*Normative Influence*
(1) Manifestation [14]	Judgmental message: facts, rationales, arguments, etc.	Source of judgment: values, preferences, group norms, etc.
(2) Motivation [9]	Being correct, knowing, etc. (task needs)	Maintain harmony, group acceptance, norms, etc. (social needs)
(3) Sources of influences	Information sharing, factual & task messages, rationales, & arguments [14]	Majority power, dominance, persuasiveness, & hierarchy status [7]
(4) Decision Model [10]	Cognitive (rational) model	Socio-emotional model
(5) Type of issue [10]	Intellective task (factual)	Judgmental task (or preference task) (value-laden)

3. CONCEPTUAL RESEARCH MODEL AND HYPOTHESES

A conceptual research model of GSS intervention into group interaction process, as shown in Figure 1, is mainly drawn on the literature review on GSS and features of five basic structures of a general purpose GSS system (e.g., Bostrom and Anson 1992). A GSS normally consists of various structures/tools to support various group work. But five basic structures of *a general purpose GSS* (e.g., Bostrom and Anson 1992) exist in almost all GSS systems and have been adopted in many GSS prior research. GSS is therefore studied as a general purpose system in this research as Rao and Jarvenpaa did before (1991). These five basic GSS structures are anonymity, simultaneity, electronic recording and displaying, structured interaction process, and enhanced information processing. Task type has been found to significantly affect group interaction process (e.g., Mor 1966) and group outcome (e.g., Poole, Seibold and McPhee 1985). Further, the two types of influences can be better elicited in an intellective and a preference task (see (5) of Table 1), and hence, these two tasks are examined in our research model.



(Legends : O-influence__Other influence,
I-influence__Informational influence, N-influence__Normative influence)

Figure 1 GSS Intervention into Group Interaction Process

In Figure 1, group influence mainly consists of informational and normative influence (e.g., Deutsch and Gerard 1955; Kaplan and Miller 1987) (we add "other influence" to represent the small portion of group influence other than informational and normative influence). *Before* GSS intervention into group interaction process (see the left-hand side of Figure 1), informational influence predominates in intellective task whereas normative influence predominates in preference task (Kaplan and Miller 1987; Kaplan, Schaefer and Zinkiewicz 1994). GSS may have a potential to influence group interaction process profoundly (Zigurs, Poole and DeSanctis 1988), so that *after* GSS intervention (see the right-hand side of Figure 1), informational influence in intellective task could be increased and normative influence in preference task could be reduced. Since informational influence would reflect task interactions and normative influence could reflect socio-emotional interactions, this model implies that GSS might enhance task interactions but dampen socio-emotional interactions. The rationales of this conceptual model will be discussed below, and the formulation of the related hypotheses will follow.

Effect of GSS on informational influence

The solution to an intellective task depends on more factual information exchange (McGrath 1984). First, *GSS structured meeting agenda* regulating group interactions could encourage more task-focused information exchange. Second, *GSS anonymity* can reduce status differences and social norms (Nunamaker et al. 1991), so that group members can focus on the merits of the expressed ideas and therefore exchange more factual information with less fear of social disapproval and offensiveness (Rao and Jarvenpaa 1991). Third, prior research reported that GSS groups tended to exchange more task information than non-computer support groups (e.g., Chidambaram, Bostrom and Wynne 1991). All these suggest that GSS could enhance factual information exchange in group interaction process thereby increasing informational influence (factual information exchange reflects informational influence, see (1), (2), and (3) of Table 1).

H1 In intellective task, informational influence will be greater in GSS groups than in non-computer support groups (or called face-to-face groups) (referring to Figure 1, I-influence (I) < I-influence (II)).

Effect of GSS on normative influence

In preference task, no correct answer exists (McGrath 1984). Hence, the solution to a preference task requires the exchanging and understanding of members' different preferences, cultural values, and affective messages (McGrath 1984). In group interactions, personal values and preferences would be better resolved in face-to-face (FtF) talks with multiple social cues. But many these social cues can be reduced in the GSS electronic communication (e.g., Sproull and Kiesler 1986), which would in turn hinder the exchanging and understanding of personal preferences and values. These personal preferences and values reflect normative influence (see (1) and (4) of Table 1). Therefore, GSS would intervene group interaction process by reducing normative influence.

H2 In preference task, normative influence will be less in GSS groups than in FtF groups (referring to Figure 1, N-influence (III) > N-influence (IV)).

Effect of GSS on group influence behavior

GSS intervention into group interaction process can be further examined from exploring the effect of GSS on group general influence behavior, because it is very important to study the same issue using multiple indices (e.g., Kaplan, Schaefer and Zinkiewicz 1994) from different perspectives (Zigurs 1993). Two variables of influence behavior and influence distribution have been commonly used in prior GSS research (e.g., Zigurs, Poole and DeSanctis 1988). Influence behavior is defined as those actions that attempt to affect or determine the course of group behavior; and influence distribution is defined as the reciprocal of variance among group members' influence behavior (Zigurs, Poole and DeSanctis 1988).

In intellective task, before GSS intervention into group interaction process, informational influence predominates in group interactions (e.g., Kaplan and Miller 1987). After GSS intervention, GSS *tends to enhance this dominant informational influence (H1)*. Even though normative influence also exists in group interactions, it is the minor component of influence behavior (e.g., Kaplan and Miller 1987). Consequently, influence behavior, mainly consisting of informational and normative influence (Deutsch and Gerard 1995; Kaplan and Miller 1987), might be *increased* as well.

H3 In intellective task, influence behavior will be greater in GSS groups than in FtF groups (referring to Figure 1, Influence (I) < Influence (II)).

Further, when performing an intellective task with a correct answer (McGrath 1984), some group members could be more knowledgeable about the task answer than others. These more knowledgeable members are likely to contribute more ideas and factual information than others in GSS setting, because GSS tends to encourage more factual information exchange (H1). As a result, these more knowledgeable members appear to be more dominant in group interactions than others, thus leading to a *less even* influence distribution.

H4 In intellective task, influence distribution will be less even in GSS groups than in FtF groups.

In preference task, before GSS intervention into group interaction process, normative influence predominates in group interactions (e.g., Kaplan and Miller 1987). After GSS intervention, *GSS tends to dampen this dominant normative influence (H2).* Even though informational influence exists in group interactions, it is the minor component of influence behavior (e.g., Kaplan and Miller 1987). Consequently, influence behavior might be *decreased* as well.

H5 In preference task, influence behavior will be less in GSS groups than in FtF groups (referring to Figure 1, Influence (III) > Influence (IV)).

The solution to a preference task requires more exchange of members' different values and preferences (McGrath 1984). *Before* GSS intervention into group interaction process (i.e. in FtF setting), the members who are better at verbal expressions or possess higher social status could be more likely to "take up the floor" to speak, and they are therefore more dominant in clarifying their preferences or values than others. *After* GSS intervention, such dominance from these members would be reduced because normative influence reflecting such dominance (see (3) of Table 1) could be dampened by GSS (H2). Hence, GSS tends to encourage more even participation from all group members.

H6 In preference task , influence distribution will be more even in GSS groups than in FtF groups.

4 RESEARCH METHODOLOGY

4.1 Experimental Design and Setting

The experiment was a two-by-two factorial design in terms of support and task type. Support was varied in GSS support versus non-computer support (FtF). Task type was varied in intellective task versus preference task. The GSS system used in this experiment was SAMM system developed by the University of Minnesota. Under the condition of non-computer support, groups just had normal face-to-face (FtF) discussion.

The experimental steps for the two tasks were: (1) group members were asked to do a warm-up task; (2) for intellective task, individual members were asked to learn the task criteria; (3) members in GSS groups were trained to learn the structured meeting agenda and the operations of SAM system; (4) before the formal meetings, group members were asked to fill in pre-meet questionnaires; (5) groups were asked to perform the tasks; and (6) after the formal meetings, grou members were asked to fill in post-meeting questionnaires. All meeting sessions were videota All groups finished their meetings within two hours. One-hundred and forty first year stude majoring in information systems from a large university participated in the experiment. Ev subject was given course credit for the participation. The subjects were randomly assigned to each treatment and each group to meet the requirement of independent samples. Group size was five in each group.

4.2 Task Type

The intellective task in this study was adopted from Zigurs, Poole and DeSanctis (1988). This task asked group members to choose from an applicant pool a given number of individuals to be admitted to an international studies program, based on scores (and/or data) of six attributes of the applicants. There is a correct answer for this task because the causal knowledge of the compon of success in the studies program was certain. The preference task in this study was adopted fro Watson, DeSanctis and Poole (1988). This task of personal trust foundation asked group members allocate funds to a list of competing projects based on their personal preferences and values. N correct answer exists for this task.

4.3 Methods of Group Interaction Analysis

Group interaction analysis for capturing valuable information in group interaction process h become increasingly important in GSS research (Zigurs, Poole and DeSanctis 1988). Kaplan a Miller's coding method (1987) was adopted for this study, and Putnam's influence analysis sch (1981) with the modifications suggested by Zigurs, Poole and DeSanctis (1988) was adopte *measure influence behavior* for this study.

Kaplan and Miller's coding method (1987) was specifically designed to measure informational a normative influence. The five categories of the coding method are: task facts, inferences from t facts, values/norms, personal preferences, and others. The first two categories meas *informational influence* and the third and fourth category measure *normative influence*. Putn ten category coding scheme was used to measure influence behavior and compute influence distribution. The first five categories of the coding scheme that form the basis for measuring influence behavior are: initiation messages, goal-oriented messages, integrative messages, implementation messages, and process messages.

4.4 Measurement of Dependent Variables

Influence behavior, informational and normative influence, were measured in two aspects: verbal behavior and non-verbal behavior. Verbal behavior was measured by viewing the videotapes and by examining the computer log files. The Kaplan and Miller's coding method and Putnam's coding scheme were used to code both verbal and non-verbal acts. More detailed coding procedure can see the papers [10] and [21]. Two coders worked together initially until they achieved mutual reliability. Then, they completed the coding of the remaining videotapes separately. The overall average inter-rater reliability achieved was 90%.

5. RESEARCH RESULTS

ANOVA test was used to detect main effects and interaction effects. If interaction effects were found, an in-depth analysis of the interactions was performed because an interaction effect takes precedence over a main effect (Keppel 1982). An in-depth analysis of the interactions was conducted using Tukey-Kramer's multiple comparison test (Kramer 1956; Tukey 1953) to specifically test hypotheses. The final research findings are summarized in Table 2.

Table 2 Research Findings

Hypotheses			Additional Findings
H1: Supported	H2: Supported	H3: Supported	A1: for a preference task, informational influence was greater in GSS groups than in FtF groups
H4: Supported	H5: Supported	H6: Supported	A2: for a preference task, informational influence was greater in GSS groups than in FtF groups

6. DISCUSSION AND IMPLICATIONS

(1) GSS did profoundly affect group interaction process by increasing informational influence (H1 and A1 supported) and decreasing normative influence (H2 and A2 supported). Because from an influence perspective, informational influence would reflect group task interactions whereas normative influence would reflect group socio-emotional interactions, *the general purpose GSS system* used in this study tended to *favor task interactions but dampen socio-emotional interactions*,

which is also in line with some prior research findings (e.g., Chidambaram, Wynne and Bostrom, 1991).

The research findings can have some implications. Future GSS research should more focus on studying how to use GSS to enhance group socio-emotional interactions. Future GSS design should incorporate more suitable theoretical structures or techniques into a GSS so that the GSS designed in this way can well support both group task and socio-emotional interactions. On the other hand, although GSS appears to dampen group socio-emotional interactions, it is not necessarily a deficit for GSS. Rather, the dampening effect can be applied to certain group work where this effect is desirable, such as to facilitate group brainstorming in creative activities, to encourage equal participation for democratization, or for the criticism blind to status.

(2) The effect of GSS on group interactions could be moderated by task type. In this study, the moderating effect of task type was demonstrated in two aspects. First, in intellective task, influence behavior was increased by GSS but in preference task, the influence behavior was decreased by GSS. Second, group influence distribution was reduced by GSS in preference task whereas the influence distribution was increased by GSS in intellective task.

An attempt to reconcile prior GSS empirical research

As mentioned in section 1, GSS has been found to enhance group task performance like decision quality, but has failed to enhance or even decreased group satisfaction. The theoretical reasons for this issue were not fully known. The conceptual model in Figure 1 and our research findings may render one theoretical explanation to this issue. First, GSS tends to increase informational influence, encourage factual information exchange, and favor task interactions (see Figure 1; H1 supported). As a result, group task performance like decision quality could be consequently increased by GSS. Second, satisfaction much involves group members' perceptions. If members in a group perceive that their socio-emtional interactions are dampened by GSS, it would be difficult for them to feel satisfaction with the group activities. Therefore, GSS failed to enhance or even decreased group satisfaction.

Limitation of this study

This study was conducted in the form of controlled laboratory experiment. Laboratory experimental study is normally limited by its relatively low external validity, although its internal validity is high. Further, our research findings should be confined to the context of the general purpose GSS system adopted in this study. Hence, the GSS effect of dampening socio-emotional interactions should not be regarded as an inherent feature of GSS. Actually, we believe that if more research are conducted and more theoretical structures are worked out for specifically supporting group socio-emotional interactions, the GSS embedded with these structures should be able to enhance group socio-emotional interactions as well.

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Personalized Home Pages - A Working Environment on the World Wide Web

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Abstract;

The World Wide Web is one of the most common interfaces to the Internet and thus to the global office as it provides an easy-to-use and self-explaining user interface for teleworkers. However WWW based interfaces are relatively rigid and are lacking ways of user customization or setting preferences. The new service oriented approach presented here builds upon the strength of the WWW interface to Internet services but enhances it by the power of individual customization. The Personalized Home Page (PHP) system is built on a framework capable to describe all Internet services in a uniform way using the terminology of weak agency. This paper gives an overview of the PHP system with a short description of the agent based framework behind. Examples introduce the actual use of the system.

Keywords:

Teleworking environment, WWW service, customization, dynamic Web page, PHP, multi-agent system

1. Introduction

The World Wide Web is one of the most common interfaces to the Internet and thus to the glo office. This technology offers a good base for any application since users face with a standard, easy-to-use interface. As teleworkers must be provided with at least as user friendly tools as they can fi in traditional offices, the complexities of the global network should be hidden. Although WW technology makes a very significant step in this direction, it still requires a good set of techni knowledge to exploit the possibilities of the global network. It is still required to know addre ports, URLs and other technical details which can be a hard job to learn from time to time.

The current usage of the Internet is based on accessing and downloading pieces of information an applications. This usually means to surf over the network several times a day, often in seve browser windows and using mostly only a part of the information provided on the acce webpages. This process is unable to hide the inherited complexity of the global office. Well designed and highly focused WWW sites may help a lot but they also take away the freedom o using the entire network as office resources.

The Personalized Home Page (PHP) system developed at MTA SZTAKI addresses these issues by offering an individually customizable interface to Internet and WWW services as presen in section 2. The motivation and several detailed examples are also discussed there. The key to the offered solutions is an agent based description of Internet services which builds up a gen framework as summarized in section 3.

2. PHP - Personalized Home Page System at MTA SZTAKI

The Personalized Home Page System (PHP) is a running prototype of a new telework environment recently developed at MTA SZTAKI, the Computer and Automation Resea Institute of the Hungarian Academy of Sciences. This new environment interfaces Internet servic to the World Wide Web based on an agent based general framework.

2.1 Motivation

In the everyday cyberspace life Web users use many Web services at the same time. They can fi these services using home made or public bookmark (URL) collections or using search engi After finding the URLs of required services their pages will be downloaded. Users usually use o parts of services/pages. Therefore the unused parts of service pages are unnecessary loaded in t parallel use of different WWW services makes users to exchange different pages within the same window or use some overlapping windows. Screen and browser resources are used uneconomically. Moreover the user is never allowed to influence the content and the layout of HTML pages or the output of network applications she uses.

Let's take the example of a user who wants to access two Web-based applications: a calculator located at site A, and a simple utility at site B that monitors the local network and reports the presence of a user, in this case one of her colleagues. Both services are available on the network, and are accessible through standard browsers. However they are located at different sites thus the user is required to open up two WWW clients, remembering or at least selecting the appropriate URLs from her bookmark collection. Moreover she does not have the opportunity to customize the location, color, initial parameters and other properties of these two applications.

Trying to overcome these difficulties the work reported in this paper is based on a concept that sees WWW servers as collections of services rather than collections of HTML pages. According to this view users do not download individual pages anymore but access a set of previously customized WWW services, that is a complex unit of service, one of her Personalized Home Pages.

2.2 Features of PHP

According to the concept of PHP WWW servers provide services and not individual HTML pages anymore. A service can be a collection of static HTML pages, a Java applet, dynamic pages generated by a program, or a mixture of all these. Users do not download individual pages from a WWW server anymore but use available complex WWW services. This service concept is nothing more but a compact packing of current WWW technology.

In PHP individual WWW services are provided by User Agents. In the current implementation any Java-capable WWW browser is appropriate as the display area of User Agents. This choice adds an extra enhancement to the network operation of agents, since the display need not be on the same machine where the User Agents reside. Two kinds of User Agent output display format are allowed: HTML or Java applet.

2.2.1 Personalized virtual URLs/pages

In PHP individual users can select the required WWW services and can build their own (virtual) pages from these selected services. The URLs of these user-defined pages can be given by the user herself. Their uniqueness for a particular user is guaranteed by the PHP system. In the current PHP implementation the last part, the path part can be defined by the users, while the first part of the virtual URLs is PHP predefined. E.g., in the case of the *http://www.sztaki.hu/A MySerices/MySearchPage* virtual URL, the *http://www.sztaki.hu/php/* is the predefined PHP system prefix and the *MyServices/MySearchPage* is the user-given path. A user can have as many own virtual pages as she wants.

2.2.2 Service selection

After the definition of the virtual URLs the user can construct the content of these pages selecting the services, that is the User Agents, from the available agent pool. The layout of the virtual pages, e.g., the position and size of the windowing areas of User Agent applets can be influenced by the user as well. The user can add or delete agents in a page, and change the configuration of the agents. Agent configuration includes display options and parameters passed to the agent. Configuration of agents is supported by another agent called Agent Personalizer. This agent behaves as a User Agent but the main task of it is the configuration of other User Agents.

2.2.3 Service use

User Agents are started when the user downloads one of her personal pages to a WWW client. PHP provides the previously set User Agent parameters. Some User Agents present a form-based interface, and they are active only for the period of time to answer the request specified by the form. Others may be active continuously (e.g., Java applets).

In PHP privacy can be ensured in two ways: a virtual page can be protected by password, or its access ,can be limited to one host (IP address). The latter case is preferred in our intranet environment where workstations for individuals can automatically download a personalized home page of the particular user without any further intervention.

Running User Agents provide their services as a result of a cooperation with other agents, called Network Agents. Network Agents can be found with the service of a specialized agent called Mediator Agent. Detailed description of the operation of PHP is given in section 3.

2.3 Creation and usage of a sample PHP page - Examples

In the following a complete process of creation and use of a Personalized Home Page is presented. During the creation process the user communicates with Agent Personalizer in order to maintain her personalized pages.

Users can manage their virtual pages from the PHP starting page (Figure 1). There are two choices: to create new virtual pages, or to maintain existing ones. For a new page, the title and the virtual

URL of the page must be given. (Figure 2). After these steps the user can construct the page, using the same methods as for page maintenance.

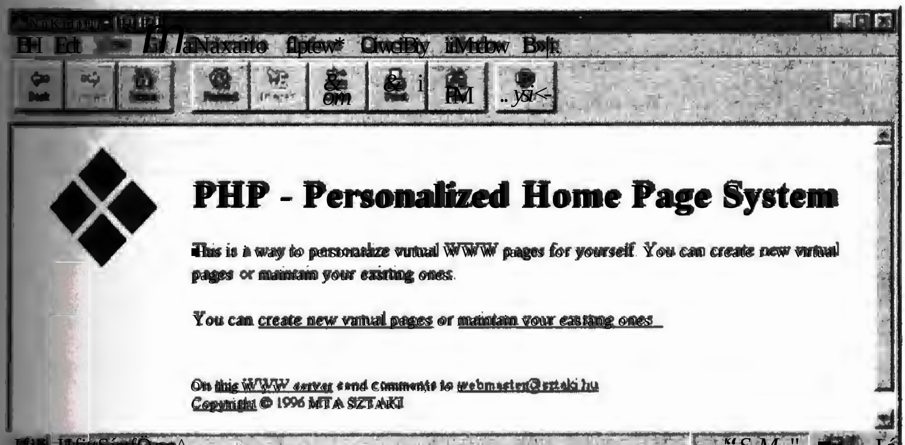


Figure 1

Page maintenance starts with user authentication, and the pages of the authenticated user are offered for modification with the following possibilities: change access permissions, modify the content, or delete the page. Under content modification user can change, delete or add new User Agents (services). If a service has parameters, they can be changed here as well. Parameters of User Agents are managed by HTML forms generated by the system. The process of configuration is controlled totally by the service itself. The parameters resulting from the configuration process are handed over to the PHP system, which stores it.

Adding a new service means the selection of the service to add from the available service (User Agent) pool. (Figure 3) In the pool there are locally available user agents and additional HTML tags to improve the layout of the page. If a User Agent is not available locally first it has to be found using a Search User Agent. After finding the required User Agent somewhere in the network it can be used locally with its registration. In the current PHP implementation this User Agent registration is a semi-manual process but in the future an intelligent Network Agent can be written for this purpose as well.

Figure 4 shows the personalized page called "BasicPage" of user Kovács with the selected WWW services: calculator, watchdog, and clock. This page can be downloaded to host *ovid* from the PHP system improved WWW server e.g., using the ***http://www.sztaki.hu/php/BasicPage*** virtual URL.

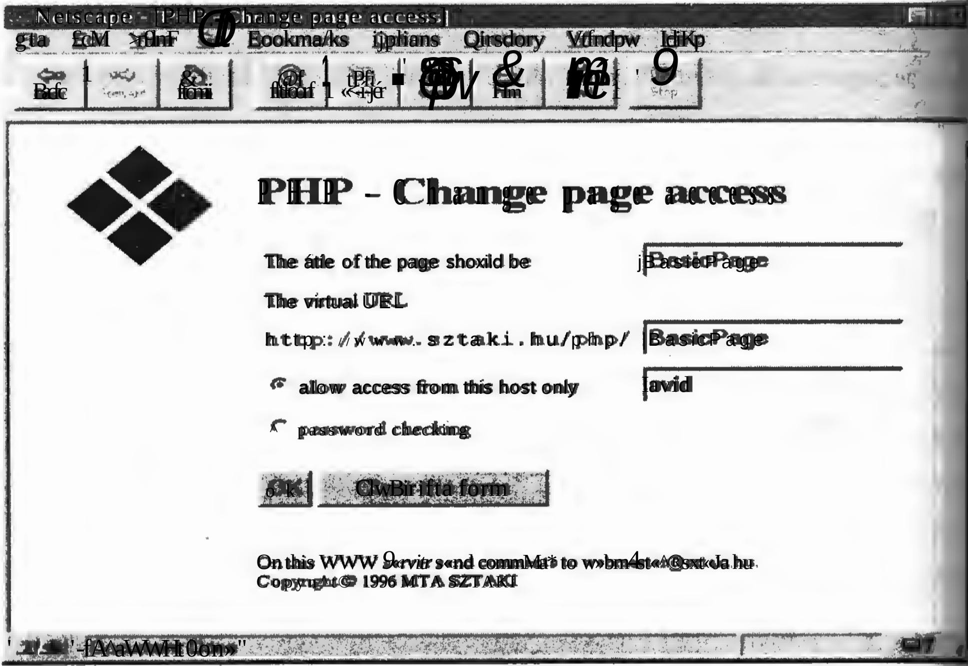


Figure 2

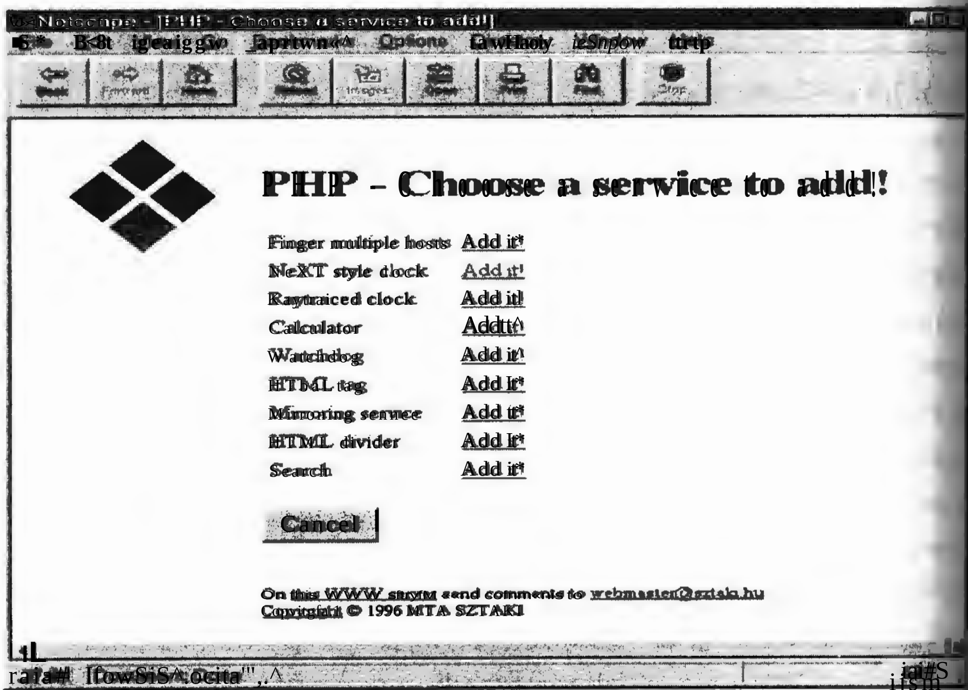
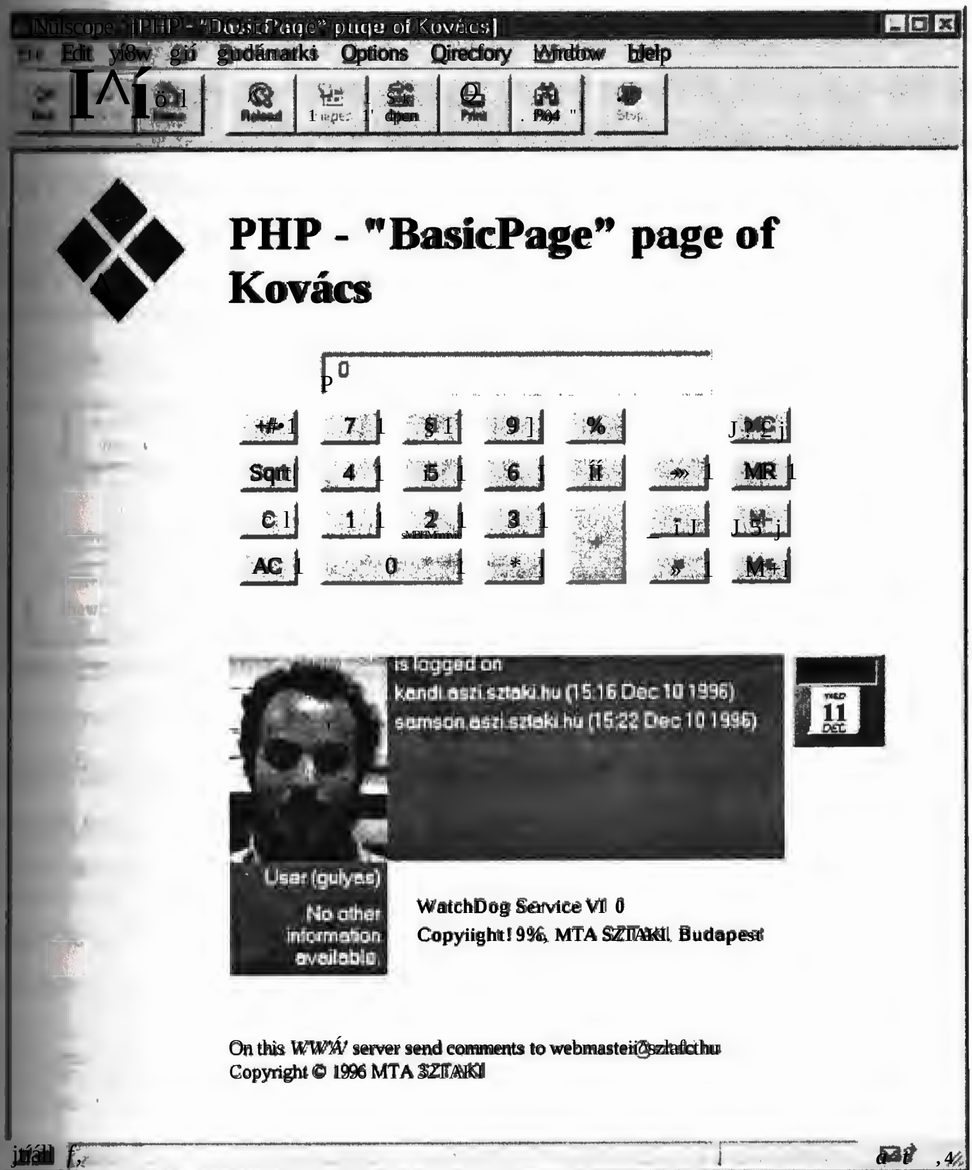


Figure 3

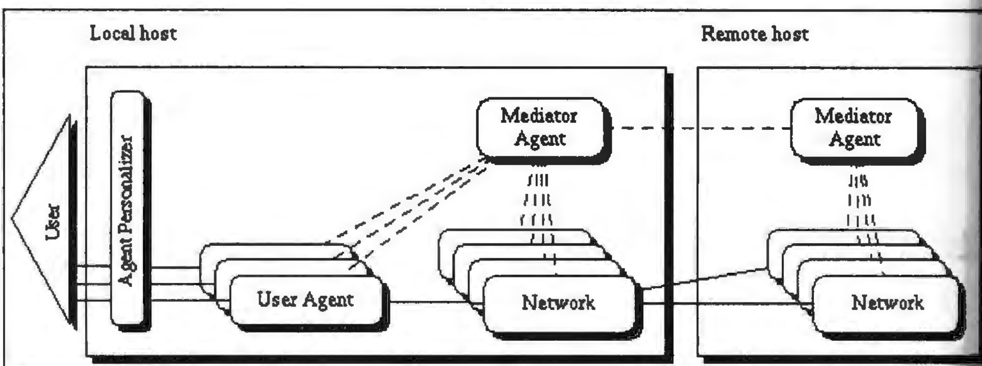


Edit
Options
Directory
Window
Help
Reload
Open
Print
Stop
PHP - "BasicPage" page of Kovács
7
8
9
%
MC
Sqrt
4
5
6
MR
C
1
2
3
AC
0
M+
is logged on
kandi.aszi.sztaki.hu (15:16 Dec 10 1996)
samson.aszi.sztaki.hu (15:22 Dec 10 1996)
User (gulyas)
No other information available
11
DEC
WatchDog Service V1.0
Copyright 1996, MTA SZTAKI, Budapest
On this WWW server send comments to webmaster@sztaki.hu
Copyright © 1996 MTA SZTAKI

Figure 4

3. The Underlying Framework

The PHP system described in the previous section operates over a general, agent based framework which makes the system expendable, flexible, and appropriate to include every exist WWW services. The framework consists of a set of interface and collaborative agents in the sen of [7]. These are the user, service and network agents. There are specialized user and service (Agent Personalizer, Mediator Agent). Their role is to manage other agents. Figure 5 shows



overview of the framework.

Figure 5

The basic operation is as follows: the User Agents on the user's PHP page start and display the results in the browser according to the configurations previously set using the Agent Person During their operation User Agents find appropriate Network Agents to cooperate with. Th cooperation and communication is facilitated by special Mediator Agents.

3.1 Basic Entities

The basic units of the system are agents in the term of *weak agency* [8] as they carry out ta autonomously on behalf of the user or other agents [3]. The system's agent classes are desc below.

3.1.1 User Agents (UA)

Each User Agent must have a way to communicate with the user. This means that it drives a u interface complying to the possibilities offered by the Agent Personalizer, and provides metho configure its operation through the Agent Personalizer. User Agents may communicate with ot agents over the Internet relying on a local Network Agent. During its operation the entire U Agent can move to the host where the user interface is displayed.

3.1.2 Agent Personalizer (AP)

The main role of the Agent Personalizer is to help the users to display agents on their screen. Each User Agent has a dedicated piece of the display window where it can talk to the user, and this piece is directly controlled by the User Agent. However there are several other tasks to be performed by the Agent Personalizer such as to arrange the display pieces of the User Agents on the screen, to store and update the personal configuration of the individual users, and to keep a database of the available User Agents and their properties. The Agent Personalizer is an agent itself, so it can participate in conversations with other agents. For example a User Agent can register itself at the Agent Personalizer. As part of the registration it has to describe itself, its configurability, its demands for the window area, etc.

3.1.3 Network Agents (NA)

Network Agents typically do not have user interfaces. These agents communicate mostly with each other, or with User Agents. Network Agents know how to communicate with other agents over the Internet with the help of Mediator Agents. They register at their local Mediator Agent giving the information about their capabilities and access modes. However the details of communication techniques may be transparent for these agents, since their needs are served by Mediator Agents. This simplifies the construction of such agents.

3.1.4 Mediator Agents (MA)

Mediator Agents provide the most important facilities for other agents: trading of agent services. The basic idea about their operation is that there must be a per host coordination point for agent communication on the Internet. These Mediator Agents help Network Agents to find each other and to build a channel for communication. The communication itself does not necessarily flow through the Mediator Agents. The process of communication is the following:

1. The Network Agent who initiates the conversation gives a required capability list to the local Mediator Agent to find a remote Network Agent satisfying the list.
2. The local Mediator Agent finds some agents meeting the requirements during a compound query process in collaboration with other Mediator Agents. MAs may use learning algorithms to solve this problem economically.
3. The initiating agent chooses one from the list of found agents (the invoked agent).

4. The Mediator Agents on the host of the initiating and invoked agents communicate with each other to agree in the following issues:
   - whether the communication of the two NA is allowed or not,
   - what should be the properties of the communication channel between the two NAs.
5. Both the initiating and invoked agents are notified about the communication possibility, and the communication channel is built.

The main tasks of a Mediator Agent are to keep a database of available Network Agents, to cooperate with other Mediator Agents in searching desired agents, and to help in building and maintaining communication channels between agents. The first two tasks indicate that there is a need to have a description language for agents, where as the most important part of this language agent capabilities can be given. However the details of this description language are out of the scope of this paper.

3.2 Examples of Agents

In the following a few examples are presented to demonstrate how everyday applications can fit into the general framework. All of these examples have running prototypes in the current PHP implementation.

3.2.1 Clock - A Simple User Agent

The agent starts by displaying a clockface and then periodically updates the clockface to show the current time. This is a simplest kind of a User Agent, it has a one-way communication with the user (showing the time), and some simple configuration options (clockface selection, etc.). As a User Agent it supports the protocol towards the Agent Personalizer, thus the Agent Personalizer can offer the Clock Agent to users, and can perform the configuration if the user wishes. At activation the Clock Agent gets its configuration, moves to the displaying host, and keeps running there. The time to display is provided by the system that displays the agent. However, with the use of a Network Agent, the time could be delivered from any other host.

3.2.2 Regular Internet Servers As Simple Network Agents

Regular Internet servers (WWW, Gopher, Finger, etc.) are in fact primitive Service Agents, because while they are not aware of communication possibilities with other agents, they show up a lot of basic agent properties. Thus any regular TCP/IP service can be integrated to our system as a Service

Agent. This is done by registering the services as Network Agents and specifying their capabilities. Capabilities and properties give enhanced search and selection possibilities to the user to find the best service according to her needs.

3.2.3 Watchdog - An Application Based On Communicating Network and User Agents

The Watchdog agent can be configured to report the presence of a user on a set of hosts. It periodically tests if the user has logged in on any of the given hosts.

The Watchdog User Agent has to find Service Agents that can inform it about the currently working persons on their hosts. The agent is started on the displaying host with the help of the Agent Personalizer. The agent then asks the Mediator Agent on its originating host to get information from the Finger Agents on the watched hosts (Figure 6). The agent could also turn to the Mediator Agent on the displaying host if it was allowed, but that solution is not secure regarding the displaying host. Finger Agents provide the functionality of a finger daemon. The Watchdog Agent then periodically queries finger information, filters it and displays the results.

3.3 Implementational Notes

The current PHP system is implemented in Perl, and agents are implemented in Perl and/or Java. Further directions are to integrate some of the accepted object distribution mechanisms [1] (e.g., CORBA [2], Java RMI) and multi-agent frameworks (e.g., [6]). In this way PHP services could exploit not only the strength of the agent metaphor but also the reliability of these architectures.

4. Summary

The research described here aimed at the development of an enhanced working environment on the World Wide Web. The PHP is a working prototype of the results of the presented research. As it was shown through examples it opens a new direction to the application of individually customized dynamic Web pages and thus to more comfortable teleworking environments. The system presented here is based on an agent based general framework for Internet services.

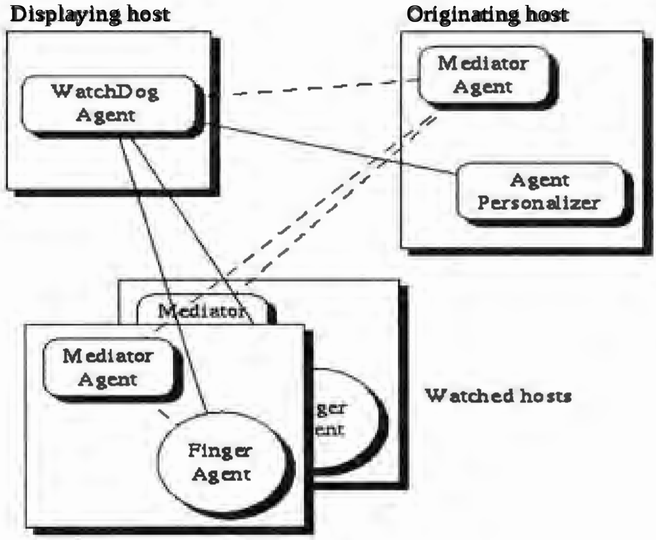


Figure 6

5. References

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Tools and Design Methods

ANALYZING COMPLEX SYSTEMS: ONLY A COMPLEX OF TECHNIQUES CAN DO THE JOB

Gerrit C. van der Veer

Abstract

Analyzing a complex system means analyzing the world in which the system functions, or the "context of use". If we want to design systems for the context of use, we need to take the task world into consideration. Based on a framework derived from Jordan we will elaborate the "map" of sources of knowledge of the task and context of use of interactive systems. We provide an overview of the relevant techniques, the validity issues related to them and their pitfalls, as well as the problem of combining insight gained from applying different techniques into a unified view or task model.

1. Introduction

Analyzing a complex system means analyzing the world in which the system functions, or the "context of use", which comprises (according to standards like [2])
- the users;
- the tasks;
- the equipment (hardware, software, and materials);
- the social environment;
- the physical environment.

If we want to design systems for the context of use, we need to take these different aspects of the task world into consideration. In traditional literature on task analysis from the HCI (Human-Computer Interaction) mainstream, the focus is mostly on users, tasks, and software. Design approaches for GroupWare and CSCW (Computer Supported Collaborative Work), on the other hand, often focus on analyzing the world first of all from the point of view of the (physical and social) environment, In both cases, more recent developments at least include some aspects that belong to the other categories, but it still looks like one has to choose for either the one view or the other. Section 2 presents an idea of task analysis approaches from the classical HCI tradition, and, at the same time, provides our view on phases in task analysis. In Section 3 an ethnographic point, as frequently applied to the design of CSCW systems, is presented, where phases in the analysis process are hardly considered. As the result of combining approaches from both HCI and CSCW design, we developed our GTA (Groupware Task Analysis) framework of modeling task knowledge, which we will describe in section 4.

Brigitte Jordan [5], though originally working from an ethnographic approach and

focusing on GroupWare applications, provides a view on analyzing knowledge of the task world that is broad enough to cover most of the context of use as now defined by the above mentioned ISO document. We will illustrate Jordan's view in Section 5, distinguishing two factors:
- sources of knowledge: (1) individual knowledge, and (2) group;
- levels of communicability: (a) explicit, and (b) implicit.

Based on applying Jordan's 2 *2 framework in actual design processes for large industrial and government interactive systems, and expanding the two factors from dichotomies to continuous dimensions, we describe a two-dimensional framework to analyze the different relevant sources of knowledge of the context of use. This framework provides a map of knowledge sources, that assists us to identify the different techniques that we might need in order to collect information and structure this into a model of the task world.

2. Task analysis in HCI design

Classical HCI features a variety of notions regarding task analysis. The concept is used to indicate different activities: (a) analyzing a "current" task situation, (b) envisioning a task situation for which information technology is to be designed, or (c) specifying the semantics of the information technology to be designed.

Many HCI task analysis methods combine more than one of these activities and relate them to actual design stages (e.g., [3]). On the other hand, some authors do not bother about the distinction: GOMS (Card, Moran, and Newell, [1]) can be applied for any of them or a combination.

2.1. Analyzing the current task situation (Task model 1)

In many cases the design of a new system is triggered by an existing task situation. Either the current way of performing tasks is not considered optimal, or the availability of new technology is expected to allow improvement over current methods. A systematic analysis of the current situation may help formulate design requirements, and at the same time may later on allow evaluation of the design. In all cases where a "current" version of the task situation exists, it pays of to model this. Sebillotte (see [11]) elaborates a method to collect task knowledge and structure this into a hierarchical model of subtasks, Scapin and Pierret-Golbreich (in [9]) elaborate on this method and provide an object oriented formalism for modeling knowledge of existing task situations, like Sebillotte mainly focusing on activities. Task models of this type pretend to describe the situation as it can be found in real life, by asking or observing people who know the situation (e.g., [4]). Task model 1 is often considered of a generic nature (e.g., [11]), indicating the belief of authors in this field that different expert users have at their disposal basically the same task knowledge.

2.2. Envisioning the future task situation (Task model 2)

Many design methods in HCI that start with task modeling are structured in a number of phases. After describing a current situation (task model 1) the method requires a re-design of the task structure in order to include technological solutions for problems and technological answers to requirements. Johnson et al. (see [3]) provide an example of a systematic approach where a second task model is explicitly defined in the course of design decisions. Task model 2 will in general be formulated and structured in the same way as the previous model, but in this case it is not considered a descriptive model of users' knowledge, although in some cases it might be applied as a prescriptive model for the knowledge an expert user of the new technology should possess.

2.3. Specifying technology (The user's virtual machine)

The third type of modeling activity that may be found in HCI design focuses on the technology to be designed. In principle this might be considered part of task model 2 (e.g., [1] in the case of GOMS). However, in other HCI approaches the actual design activities focus on the technology as such (e.g., [14]). In this part of design the activity is focussed on a detailed description of the system as far as it is of direct relevance to the end-user. Oberquelle (see [7]) introduces the concept "virtual machine" to indicate "the functionality of the system ... where implementation details and details of the underlying hardware are suppressed". Tauber ([13]) elaborates the concept of the user's virtual machine (UVM) which indicates the total of user relevant knowledge on the technology, both semantics (what the system offers the user for task delegation) and syntax (how task delegation to the system has to be expressed by the user). We will borrow the Term UVM to separate the design of technology (as far as relevant to the end-user) from the design of the "new" task situation as a whole, mainly because the UVM models the detailed solution in terms of technology, where task model 2 focuses on the task structure and work organization. In actual design iteration will be needed between the specification of these two models, which should be an explicit activity, making the implications of each obvious in its consequences for the other.

2.4 HCI task models represent a restricted point of view

All HCI task modeling is rather narrow focused, considering mainly individual people's tasks, although Johnson (e.g., [4]) considers the aspect of roles and the phenomenon of allocating subtasks to different actors. Most HCI approaches are based on cognitive psychology. Johnson refers to knowledge structures in long term memory. Tauber refers to "knowledge of competent users". HCI approaches focus on knowledge as can be modeled after individuals who are knowledgeable or expert in the task domain, whether this domain already exists (task model 1) or still has to be re-structured by introducing new technology (task model 2 and the UVM).

As a consequence of their source, HCI models seldom provide an insight in complex organizational aspects, in situational conditions for task performance, and in complex relations between tasks of individuals with different roles. Business processes and business goals are seldom part of the knowledge of individual workers, and, consequently, are seldom related to the goals and processes as found in HCI task modeling.

3. Design approaches for CSCW

CSCW work stresses the importance of situational aspects, group phenomena and organizational structure and procedures (Schael, [10]; Shapiro, [12]). Shapiro even goes as far as stating that HCI has failed in the case of task analysis for cooperative work situations, since generic individual knowledge of the total complex task domain does not exist. CSCW literature strongly advocates ethnographic methods.

3.1. Ethnography

Ethnographers study a task domain (or "community of practice") by becoming a participant observer, if possible with the status of an apprentice, being accepted as an outsider in this respect and being themselves aware of their status of analyzing observer. The ethnographer observes
the world "through the eyes of the aboriginal" and at the same time is aware of his status of an outside observer whose final goal is to understand and describe for a certain purpose and a certain audience (in the case if CSCW: a design project). Ethnographers start their observation purposely without a conceptual framework regarding characteristics of task knowledge, but, instead, may choose to focus on activities, environments, people, or objects. The choice of focus is itself based on prior ethnographic observations, which illustrates the bootstrapping character of knowledge elicitation in ethno-methodology. Methods of data collection currently start with video recording of relevant phenomena (the relevance of which, again, can only be inferred from prior observation) followed by systematic transaction analysis, where inter-observer agreement serves to improve reliability of interpretation. Knowledge of individual workers in the task domain may be collected as far as it seems to be relevant, but it is in no case a priori considered the main source, and will never be considered indicative for generic task knowledge.

3.2. The scope of ethnography

The ethnographic approach in unique in its attention to all relevant phenomena in the task domain that are not explicitly verbalizable by (all) experts (see [6]). The approach attends to knowledge and intentions that are specific for some actors only, conflicting goals, cultural aspects that are not perceived by the actors in the culture, temporal changes in beliefs, situational factors that are triggers or conditions for strategies, and non-physical objects like messages, stories, signatures and symbols, of which the actors may not be aware of their functions in interaction.

Ethno-methodology covers the methods for information collection that might serve as a basis for developing task model 1 (and no more than this since ethno-methodology only covers information on the "current" state of a task domain). However, the methodology for the collection of data and the structuring into a total task domain description is often rather special and difficult to follow in detail. The general impression is that CSCW design methods skip the explicit construction of task models 1 and 2 and, after collecting sufficient information on the community of practice, immediately embark on specifying the UVM, based on deep knowledge of the current task situation that is not formalized. This might cause two types of problems; on the one hand, the relation between specifications for design and analysis of the current task world might depend more on intuition than on systematic design decisions; on the other hand, skipping task model 2 may lead to conservatism in view on organizational and structural aspects of the work for which a system is to be (re)designed.

4. Conceptual framework for GTA

The framework for groupware task analysis that is presented here is based on comparing the different approaches mentioned earlier, and on an analysis of existing and proposed systems for HCI and CSCW (see [17]).

The framework as such is intended to structure task models 1 and 2, and, hence, as a guidance for choosing techniques for information collection in the case of task model 1. Obviously, for task model 2 design decisions have to be made, based on problems and conflicts that are represented in model 1, in combination with requirement specifications as formulated in interaction with the client of the design. For a discussion of these design activities, see [16].

Task models for complex situations need to be composed of different aspects. Each describes the task world from a different viewpoint, and each relates to the others. Consequently, the resulting final task model will be redundant at the level of representation for human readers. This will allow designers to read and to design from different angles, and provide slots for design tools to guard consistency and completeness. The three viewpoints (focus on agents, work, and situation, respectively) that we will apply in our approach are a superset of the main focal points in the domain of HCI as well as CSCW. Both design fields consider agents ('users' vs. 'cooperating users' or user groups) and work (activities or tasks, respectively the objectives or the goals of 'interaction' and the cooperative work). Moreover, especially CSCW stresses the situation in which technological support has to be incorporated. In HCI this is only sometimes, and then mostly implicitly, considered. In this section we will elaborate our conceptual framework.

4.1. Agents

The first aspect focuses on agents. "Agents" often indicates people, either individual or in groups. Agents are considered in relation to the task world, hence, we need to make a distinction between agents as acting individuals or systems, and the roles they play. Moreover, we need the concept of organization of agents. In situations where modern information technology is applied, actors will sometimes be non-human agents, or systems that comprise collaboration between human agents and machine agents.

4.1.1. Actor

This label mostly refers to individual persons. Important for task modeling is to identify relevant types of actors, and to characterize them on relevant characteristics. Types may be identified based on two different types of variables; (1) psychological characteristics, like cognitive styles or spatial ability (see [15]); and (2) task related characteristics like expertise or knowledge of information technology.

4.1.2. Role

Roles indicate classes of actors to whom certain subsets of tasks are allocated, by free choice or as the result of the organization. By definition roles are generic for the task world. More than one actor may perform the same role, and a single actor may have several roles at the same time. Roles may be performed temporarily, be negotiated between actors and accepted or refused. Actors may have internal (mental) representations of their own roles and others' roles and roles may be represented externally by instrumental or symbolic behavior and by objects (white coat, stethoscope, and wig).

4.1.3. Organization

'Organization' refers to the relation between actors and roles in respect to task allocation. The organization describes the agent structure in the task domain. Part of the organization is generic (as far as the structure of roles is concerned), another part concerns the current episode in the history of the task world (the organization as far as dependent on current individual actors and the roles they currently perform). Delegation and mandating responsibilities from one role to another is part of the organization, as is the way roles are allocated to actors. In organizational structure roles can be hierarchically related in several ways: a role can be a subtype of another role (a sales manager is a manager), or roles may be part of a role (a nurse is part of the company health department, which is part of the personnel division).

4.2. Work

Some approaches refer to goals as the unit of description of work (GOMS: [1]), but we prefer to focus on the structural as well as dynamic aspect of work, hence, we will take 'task' as the basic concept, and 'goal' as an attribute. The concepts of task and goal in most frameworks have either a many to one or a one to one relation – several tasks may have the same goal, and each task has exactly one goal. In activity theory tasks are referred to as 'actions' (which are, like in HCI task analysis approaches, considered to be hierarchically structured), where long-term tasks are referred to as 'object' or 'motive' (Nardi, [6]). We make a distinction between tasks and actions in the 'classical' HCI terminology, and, moreover, we will elaborate task structure and the structure-related concepts of protocol and strategy.

4.2.1. Task

Tasks can be identified at various levels of complexity. The unit level of tasks needs special attention. Payne and Green (in [8]) call this the 'simple task', but this notion may either indicate an artifact of a system, or a psychological concept, which sometimes results in ambiguity in analysis. We need to make a distinction between (1) the lowest task level that people want to consider in referring to their work, the 'unit task' (Card, Moran, and Newell, [1]); and (2) the unit level of task delegation that is defined by the tool that is used in performing work, like a single command in command driven computer applications. This last type of task we will call 'Basic task' (Tauber, [14]). Unit tasks will often be role-related.

Complex tasks may be split up between actors or roles. Unit tasks and basic tasks may be decomposed further into (user) actions and (system) events, but these cannot really be understood without a frame of reference created by the corresponding task, i.e., actions derive their meaning from the task.

4.2.2. Task structure

The task structure will often at least partially be hierarchical. For the indication of temporal order and dependency structure, concepts like the 'constructors' of Scapin and Pierret-Golbreich ([9]) are relevant. Task structures for task model 1 are not always known by single actors, mainly when different roles are involved in performing different subtasks. On the other hand, performance on certain subtasks may influence the procedures for other subtasks.

4.2.3. Actions

Actions are identifiable components of basic tasks or unit tasks, which have a meaning in performing a unit of work, but which derive their meaning only from the task they are part of. For instance hitting a return key has a different meaning depending on whether it concludes a command, or confirms the specification of a numerical input value. The speech act of confirmation has a different meaning depending on whether it follows another person's question or eommand. On the other hand, actions are the smallest elements of a basic or unit task that change or define the meaning of that task. In describing actions, the goal is to identify the meaning, not the physical characteristics.

In Activity theory these components seem to be equivalent to 'operations', which are at the level of automatism and the elements of subconscious feed-back loops. This theory stresses the phenomenon that actions may become operations by continued learning and experience and that they must become 'actions' again when the operations are frustrated. Typical actions in HCI and CSCW are the speeification of objects or events, and speech acts. Actions may aim at changing (or operating on) attributes, 'location' or existence of objects, change attributes of the environment, or may effeet mutual task performance between different actors. Actions that concern the 'content' of an object may often be considered to act on other objects that are contained in the current object ('themes', see below). Actions, as parts of basic tasks or unit tasks, are often not explicitly 'known' (i.e., verbalizable) or actors are reluctant or unable to be very precise in this respect.

4.2.4. Protocols

This concept indicates actual 'rules' as turn out to be applied for decomposing tasks, to be distinguished from 'rules' that may be stated explicitly in instructions which are sometimes not actually followed. Protocols may be situated, i.e., the environment and the presence of actors with certain roles may constitute conditions for protocols to be triggered.

4.2.5. Strategies

'Strategies' indicate structures that can be considered protocols used mainly by experts or typically preferred by them. These structures will often be situated in the same way as protocols are. Strategies may have started from explicit problem solving and knowledge formation episodes and subsequently have become implicit expert knowledge. Strategies will be role related.

4.3. Situation

Analyzing a task world from the viewpoint of the situation means detecting and describing the environment (physical, conceptual, and social) and the objects in the environment. Object description includes an analysis of the object structure.

4.3.1. Object

Each thing that is relevant to the work in a certain situation is an object in the sense of task analysis. In this framework, 'objects' are not defined in the sense of 'object oriented' methods. Objects may be physical things, or conceptual (non-material) things like messages, gestures, passwords, stories, or signatures. Non-material objects as well as physical objects may in the task situation be referred to by external representations of different character: verbal labels, graphics, metaphors, gestures. Actors that perform a certain role may be objects in a task situation and will be labeled 'active objects'. Non-human system components like computer based agents may also be active objects.
The identification of relevant objects will depend on the condition of knowledge (explicit or implicit) and on whether the object figures in a task for a single person or in group situations. Relevant objects may be used to transport meaning and information between different agents without any of them being aware of the objects' nature (e.g., anecdotes that contain strategic information). As far as explicit knowledge is involved, analysis of verbal material from archival sources or from interviews may be of help, starting with the identification of nouns in relation to task references. For implicit knowledge about objects, observations and ethnographic methods have to be used, both for detection and for description.

4.3.2. Object structure

In order to describe the semantics of objects, two kinds of relations between object types have to be identified.

1. Object types are related via a type hierarchy, indicating sub-type - super-type relations. Sub-types inherit the characteristics of their super-type as far as no further specifications have to be added. Analysis will reveal the exact relations of object types of certain levels in a type hierarchy featuring in the task world.

2. Semantic relations between object types may metaphorically be indicated by place relations, where a certain type of object can be 'in' or 'on' another object type (Tauber, [14], uses the concept 'theme' for this relation in his ETAG formalism), and where objects may 'move' from one place to another (each place being provided by an object).

Apart from the relation between object types, objects will be related to tasks as agent (active objects), as subject, or as featuring in conditions of task structures. The identification of object structures will be an analytic (HCI type) activity, based on verbal protocols from actors and on systematic observation of the situational relations in which objects are used.

4.3.3. Environment

The task environment is the current situation for the performance of a certain task. It includes actors with roles, conditions for task performance and for strategies and protocols, relevant objects, and artifacts like information technology that are available for subtask delegation. The history and temporal structure of relevant events in the task situation is part of the actual environment. The environment features as condition for task structures (inclusive protocols and strategies as far as these are situated). The analysis and description of environments often will need ethnographic methods.

5. Sources of knowledge and methods of collecting the knowledge

Collecting task knowledge for analyzing the current situation for a complex system has to start by identifying the relevant knowledge sources. In this respect, we refer to a framework derived from [5], see figure 1.

task world knowledge	individual	group
explicit	a. knowledge and skills	c. models/stories/instructions
implicit	b. intuition/expertise	d. culture/community of practice

Figure 1: Dimensions of knowledge of complex task domains

Relevant task domain information may have to be collected focusing on different phenomena, using different methods of data collection. Based on an analysis of the character of the knowledge sources in this framework, different methods are identified to collect all information needed to construct a model of the current task world.

5.1. Collecting task knowledge

Going from knowledge that is available from professionals in the task world and domain experts, via knowledge that is present in the culture and in the social environment towards artifacts and the physical environment, we encounter knowledge in the cognitive psychological sense, awareness and anecdotal material in the culture, and traces of manufacture and use as well as environmental opportunities and constraints.

Going from explicit knowledge, via skills and rule based behavior, through intuitive and instinct-like behavior in individuals and groups and culture, we meet documented knowledge and conscious representations, stories and myths, as well as unspoken and unspeakable insights that still prove to be valid for guiding or monitoring adequate behavior in the context of use.

For task knowledge in cell a, psychological methods will be used including those elaborated by [4] and [11]: interviews, questionnaires, think-aloud protocols, and (single person oriented) observations. For knowledge indicated in cell b observations of task behaviour will have to be complemented by hermeneutic methods to interpret mental representations (see [15]). For the knowledge referred to in cell c the obvious methods concern the study of artifacts like documents and archives. In fact all these methods are to be found in classical HCI task analysis approaches.

The knowledge indicated in cell d is unique in that it requires ethnographic methods like interaction analysis (see [5]). Moreover, this knowledge can be in conflict with what can be learned from the other sources, as is already shown in the examples presented in the previous sections. First of all, explicit individual knowledge often turns out to be abstract in respect to observable behaviour, and turns out to ignore the situatedness of task behaviour. Secondly, explicit group 'knowledge' (e.g., expressed in official rules and time schedules) often is in conflict with actual group behaviour, and for good reasons. In fact, official procedures do not always work in practice and the literal application of them is sometimes used as a political weapon in labor conflicts as a legal alternative for strike. In all cases of discrepancy between sources of task knowledge, ethnographic methods will reveal unique and relevant additional information that has to be explicitly represented in task model 1.

The allocation of methods to knowledge sources should not be taken too strictly. In fact the knowledge sources often cannot be located completely in single cells of the conceptual map. The main conclusion is that we need these different methods in a complementary sense, as far as we need information from the different knowledge sources.

It can be shown that different techniques of date collection and date analysis are needed for different types of knowledge, and these techniques seem to map systematically on to the "two-dimensional" framework of knowledge sources. Related to the different types of knowledge and the techniques is the notion of reliability of collection of information, and the validity of the resulting knowledge. We consider the validity of the knowledge in relation to the history and time aspects of the task world. E.g., experts may base their current knowledge on training they received in a different phase of equipment application, and documents may reflect a rule that is yet to be accepted by the authorities who control task performance.

5.2 Representing task knowledge

In representing task knowledge in a task model, GTA proposes three different types of representation: concept templates, relational graphs, and structural graphs.

Concept templates: For some concept in GTA it may be useful to define an object class, where the instances of that type are characterized by relations to objects of the same and other types. Thus far we regularly use object classes for roles, for tasks and for things, and for agents. Each object class is characterized by the relevant relations to other concepts. Figure 2 presents an example of an object for a calendar situation.

Object: timeslot	
superordinate: memo	**subordinate:** day_slot hour_slot quarter_hour_slot
themes; meeting holiday business travel	
places: month calendar week calendar day calendar	
relevant tasks: cancel meeting initiate meeting postpone meeting receive meeting cancellation forward meeting cancellation	
actors/roles; competence meeting participant; initiate cancellation meeting initiator; prohibit cancellation	
passive/active: passive	
attributes: time, date	

Figure 2. Object template - example from the electronic calendar and meeting organizer

Relational graphs: Relations between objects of the same class are represented in the object structure, e.g., see the subordinate and super-ordinate slots and the themes and places slots in figure 2. For purposes of design decisions, however, a graphic representation will provide a more useful overview. We will benefit from a tree representation of type-hierarchy, as well as from a graphic representation of the themes-places relation where themes are objects that may find place in or on the current object, and the places are other objects that have the current object as a theme. In the same way relational graphs may show the semantic relation between roles and between tasks, see Figure 3.

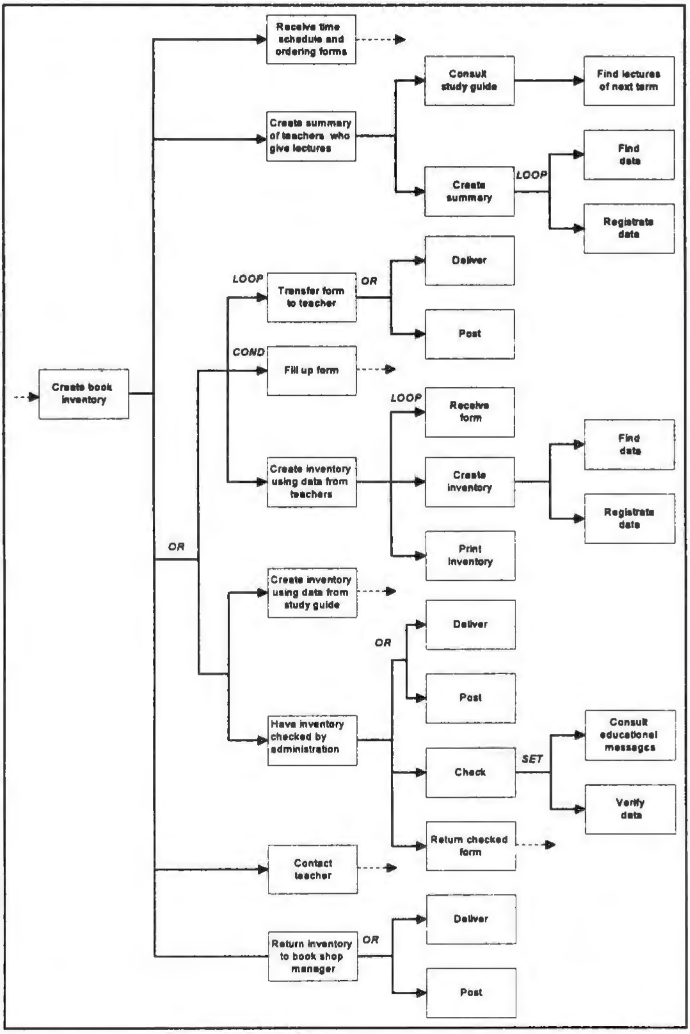

Figure 2. Fragment of the hierarchical task structure of a book distribution task

Structural graphs: A last graphical representation that we found beneficial for representation of the task structure refers to relations between objects of different classes E.g. we regularly will need to represent the relation between task structures and roles over time for which a certain kind of workflow diagram may be suitable, like in Figure 4. Likewise the relation between task structures and things often needs to be represented.

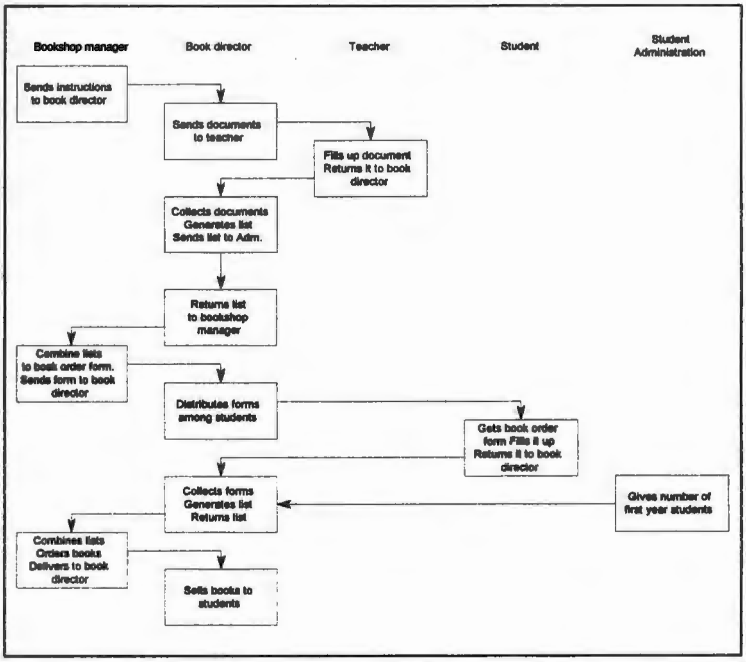

Figure 4. Global work flow representation of the university book selling case

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EXPLOITING MULTI-AGENT SCHEME FOR WIRELESS PCS CHANNEL ALLOCATION

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Abstract

The experience with the application of a multi-agent scheme to channel allocation in Wireless Personal Communications (WPC) is reported in this article. The scheme consists of a collection of problem-solving agents that autonomously execute and coordinately cooperate each other to achieve the wireless PCS channel allocation for handoff and initial access. To possess the features of the parallelism, community, and cooperation, there are three key components including knowledge source, blackboard system, and control mechanism are built in the scheme. It was implemented based on Java Expert System Shell (Jess). We treat the application in a wireless PCS testbed and compare the performance in terms of the probability of forced termination and call blocking. The results show that the scheme can obtain a high degree of goodness in PCS channel allocation.

KeyWords: Multi-Agent Scheme, Wireless Network, Personal Communications Services (PCS), Channel Assignment

1. Introduction

PCS has been widely recognized as one of the most significant growth areas in telecommunications for the decade to come [1]. Due to the deregulation process in the telecommunication industry and the technological advances in wireless communications, the service providers relating to personal communications grow rapidly in Taiwan. Through the promotion of service agents, the mobile users increase doubly. Because of the stimulant of business, PCS services will make a reality earlier. It introduces the urgent technological challenge: the need to increase the spectrum efficiency of wireless PCS networks [2], However, a good strategy for PCS channel allocation is referred to

step toward increasing the spectrum efficiency.

PCS channel allocation schemes can be divided into the fixed channel allocation (FCA), dy channel allocation (DCA), and hybrid channel allocation (HCA). Many WPC channel assig strategies have been reported in a large number of papers and utilized in the EMM (Ent Mobility Manager) [3-5]. However, these different strategies will focused on the specific poia authors concerned with. Thus each strategy only benefits in the specific service environments as the DCA-based strategies are less efficient than FCA-based strategies under high load con To quickly pave the way for realizing the ubiquitous PCS environment, a scheme which cons the advantages of the existing strategies is needed. In view of this, we propose a multi-agent sc which integrates the advantages of the existing strategies for wireless PCS channel allocation.

Multi-agent scheme emphasizes how agents negotiate collective solutions from different PC channel allocation strategies [6,7]. The scheme allows EMM to easily integrate many exi problem-solving techniques simultaneously. To realize the scheme, three major designed ma are knowledge source, blackboard module, and control mechanism. A treat for the proposed sch for PCS channel allocation is done in our Laboratory.

The rest of article is organized as follows. In Section 2, we introduce the multi-agent sch implemented based on expert system tool *Java CLIPS*. In Section 3, an integration of PCS ch allocation strategies and multi-agent scheme is identified. The performance in terms of probability of forced termination and call blocking is analysed and presented in Section 4. Fin we give a conclusion.

2. Proposed Multi-Agent Scheme

A multi-agent paradigm consists of a collection of interacting problem solvers (problem-sol techniques) based on a set of processors/agents connected to form a communication network. Su an environment needs to interoperate to share knowledge/data and cooperate to joint pro solving. Thus, the paradigm is designed for a distributed processing system. Each agent in such environment can compute autonomously and cooperate with other agents to reason a satisfa solution for a large-scale application. To realize this idea, three major designed modules are knowledge source, the blackboard module, and the control mechanism. The multi-agent par as well as the relationship of different modules are illustrated in Figure 1. In the following we will introduce each problem-solving module, respectively.

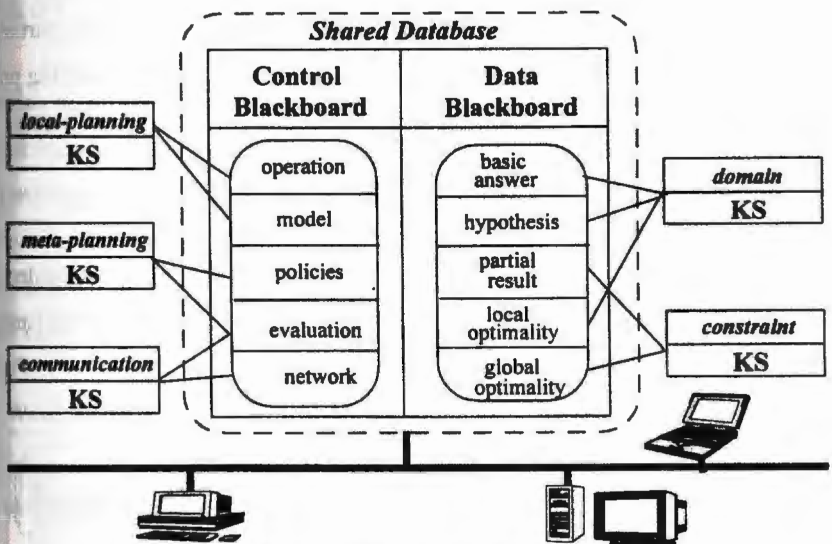


Figure 1: Proposed multi-agent paradigm

2.1 Knowledge Sources (KSs)

For a large-scale application, it is envisioned that many expert systems (problem solvers) will be developed as processors/agents to assist analyst with problem resolution. Each particular expert, KS, possesses its knowledge and reasoning philosophy (that is the problem-solving techniques). From the point of view in industrial applications and our experiment, five categories of KS are classified as follows: local-planning KS, meta-planning KS, communication KS, domain KS, and constraint KS. The local-planning KS focuses on incrementally collecting the partial results derived from the problem-solving techniques. The meta-planning KS maintains the global status and makes decisions. The communication KS receives and broadcasts results in a network environment. The domain KS manipulates the heuristic rules and facts related to application domain. At last, the constraint KS defines the problem-solving criteria.

2.2 Blackboard Module

The blackboard system is shared by cooperating KSs which work together to achieve the problem-

solving result. In the paradigm, the blackboard module, which is a shared database in the ph
view, consists of a data blackboard and a control blackboard. For parallelism, commu
plurality, both blackboards are structured into several layers. Data blackboard which con
synthesizing results is separated into five layers: basic answer, hypothesis, partial result,
optimality, and global optimality. In addition, to enhance the efficiency of inferring process, c
blackboard is composed of operation, model, policies, evaluation, and network layers.

2.3 Control Mechanism

To design a multi-agent *cooperative* paradigm, two basic issues should be considered. One
optimal control of each problem-solving technique; the other is the transfer of the partial resu
a global optimal [8]. To attack the two issues, a control mechanism is described in Figure 2 a
actions are introduced as follows.

Action 1; Both domain knowledge and constraint knowledge are broadcasted to every
assigned to participate the problem-solving tasks.

Action 2: Each agent executes the local control based on the blackboard system.

Action 3: Partial result or local optimal results are broadcasted to an idle agent for hand
conflict resolution.Therefore, the critical result is bound.

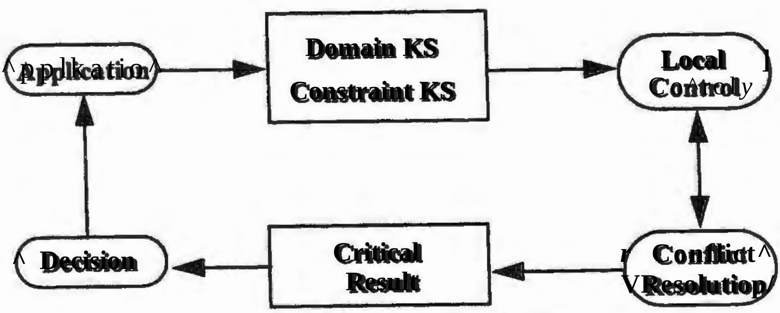


Figure 2: Proposed control mechanism

2.4 Implementation

The prototype of multi-agent paradigm is implemented based on the existing products: *Jess*
Jess is a clone of the popular expert system shell (CLIPS) written entirely in Java

herzberg.ca.sandia.gov/jess/) [9]. Since CLIPS is based on C language and Java-based user interface is very flexible, *Jess* was selected as the basis to develop the autonomous functions of agents. The functions of interoperability are implemented by distributively processing the *Jess* which is the source code of CLIPS by adding RPC function call facility (see Figure 3).

The scenarios of an agent are described in Figure 4. The initial state begins on *start* state. Upon running, the agent begins to compare the list of facts with precondition in rules (*match* state). Two situations will happen whether the match was found or not. If there is no firable rule, this agent will go to *sleep* state until be awaken by another agent. If there are some firable rules, the most critical one will be selected by predefined criterions (*conflict resolution* state), then action should be carried out and the effect should be broadcasted to other agents.

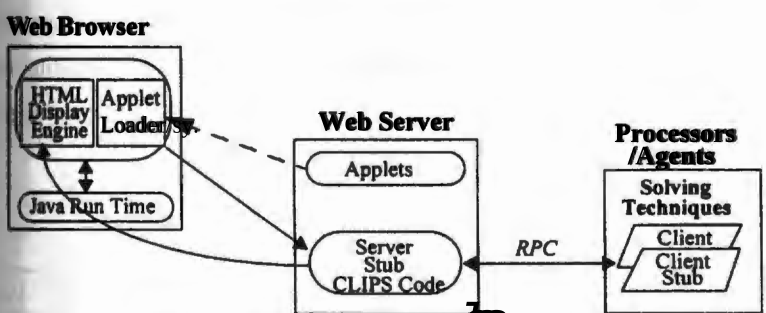


Figure 3: The conceptual model of Jess

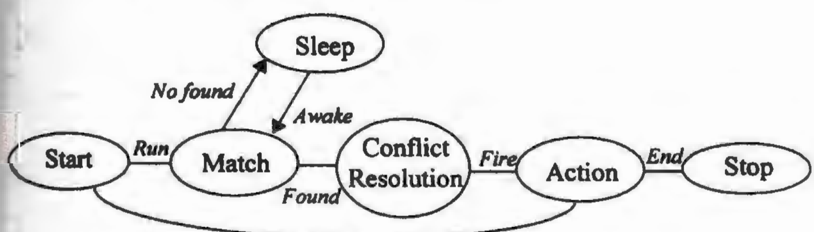


Figure 4: The scenarios of an agent

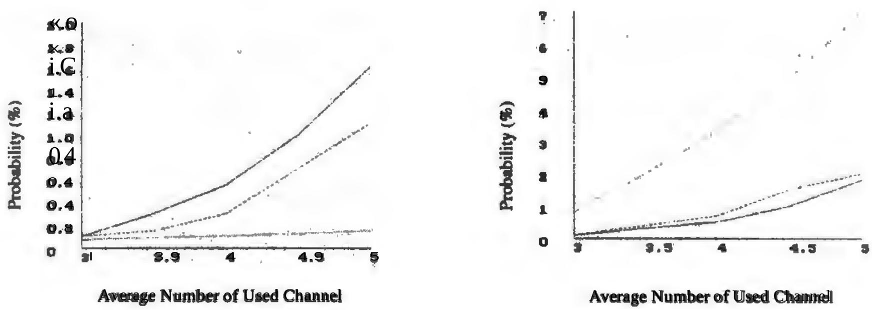
3 Proposed Application Architecture

In this section, we give an introduction of the application architecture for PCS channel allocation by using multi-agent scheme and then discuss the key components on the architecture.

3.1 Application Domain

PCS service has been recognized as one of the most significant milestones in telecommunicai Taiwan. When a PCS subscriber wishes to make or receive a call, the portable attempts to seize available channel for this call. Owing to the limited number of spectrum, if there is no avai channel, the new call is blocked. When a PCS user moves from one service area to another whi call is in progress, a handoff to new service area is required to maintain continuity and quality of progressing call. If the new service area does not have an available channel, the handoff call may terminated.

The forced termination of a handoff call and the call blocking of an initial access are two impo criterions in PCS services. However, from the aspect of limited spectrum and the cost-of-an point of view, the probability of forced termination and call blocking is a trade-off. A real testi three simple strategies is shown in Figure 5. Therefore, most of existing technologies are t flexible for each one of two criterions. Multi-agent scheme which integrates existing strategia generate the PCS channel allocation plan which meets the required criterions simultaneously.



(a) Forced Termination (b) Call Blocking

non-priority strategy
first-in-first-out strategy
reserved channel strategy

Figure 5: A test for the performance of three existing strategies

3.2 Problem-Solving Strategies

Channel allocation strategies can be divided into fixed channel allocation (FCA), dynamic channel allocation (DCA), and hybrid channel allocation (HCA). In the FCA-based strategy, a number of channels permanently assigned to each cell (a service area) for its exclusive use are not adapted to changing traffic conditions and user distribution. So, the strategy is efficient if the traffic distribution of the PCS system is uniform. In DCA-based strategies, all channels assigned to radio service areas as calls arrives provide flexibility and traffic adaptability. And HCA-based strategies are a mixture of the FCA and DCA techniques. A lot of strategies we concern are listed in Table 1.

```
(defrule simple-fixed-channel-allocation
        (and (= (<traffic> heavy))
             (= (<channel-reusability> maximum))
             (= (<forced-termination> high))
             (= (<cell-environment> large))
             (= (<quality-of-service> unstable))
             ......
        =>
        (printout t Simple Fixed Channel Allocation is a flexible strategy crlf
        (assert (strategy-is fixed-channel-allocation))
        (sys blocked)         /* compute the blocking probability
        (sys forced))))       /* compute the forced-termination probability
```

Table 1; The different strategies for PCS channel allocation

[illegible]	Strategy	Description
FCA	Simple FCA	described in the above paragraph
	Simple Channel Borrowing	After all channels are used in a service area, an available channel from a neighbouring service area is borrowing
	Hybrid Channel Borrowing	The channels assigned to each service area are divided into two subset, A & B. Subset A is for local channels and subset B is for borrowable channels
DCA	Simple DCA	The first available channel within the reuse distance is assigned to new call
	Mean-Square DCA	The selection of available channel is based on the minimization of the mean square of the distance
	Nearest-Neighbour DCA	The selection of available channel is occupied in the nearest cell
HCA	Multi-agent scheme proposed here is a strategy of HCA	
Handoff Strategy	Guard Channel Strategy	The strategy generates an optimal channel assignment between normal and guard channels which ensure priority of handoff calls and guarantee the desired blocking probability of the initial access
	Queueing Strategy	No new call is granted a channel before the handoff requests in the queue are served

3.3 Knowledge Sources

From the view of application, the domain KS and constraint KS are two major components driving the multi-agent scheme. According to the experimental data in our Laboratory, we generate the domain KS including the rule base and data base and then put these knowledge into CGI (Common Gateway Interface) interface. A simpled rule in the rule base and a simpled data in the data base are listed in the following

(deffacts simple-dynamic-channel-allocation
(traffic light)
(traffic moderate)
(quality-of-service stable)
(forced-termination low)
(signaling-load high)
.....
(computational-effort high))

When the scheme is enabled and the current status in the tested PCS environment is input, domain KS is then fed into the scheme and therefore the scheme will infer the feasible solutions which meet the basic rules. In the previous section, we had introduced a key component, mechanism, for getting the optimum solution. To receive the optimum solution, we will define criterions in the constraint KS. Form the aspect of the PCS service, we know the probability of forced termination for handoff call and the probability of blocking for initial access are two concerns. Thus, the two values are referred to as our criterions and embedded in the constraint KS. By doing so, each solution from the multi-agent scheme will meet our service requirements.

3.4 Application Architecture

Following the architecture in Figure 3, we set up an application environment illustrated in Fig. The operational steps are described as follows. Firstly, the data user concerns is input from the browser and the current status in the tested PCS environment is automatically fed from a network management system [10]. Secondly, the relevant *Applets* are enabled and then the agents are activated to execute the problem-solving tasks. Thirdly, the feasible solutions which the basic rules are got. Finally, these feasible solutions are evaluated in terms of the forced termination and call blocking probability and then the optimum solution which meets our criteria is generated.

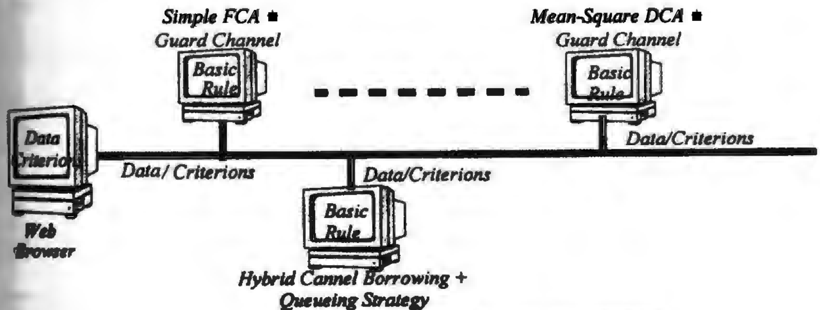


Figure 6: The application architecture

4. Experimental Analysis

To investigate the feasible in the PCS channel allocation, we analysis the different strategies and then the performance in terms of the blocking probability and forced-termination probability is drawn in Figure 7. Through the operation of the multi-agent scheme, the performance is shown in Figure 8.

From the results presented so far, several observations are in order:

(1) Only simple FCA is suitable for the *high* traffic, therefore, the simple FCA is selected as the strategy while offered load over 4.5 Erlang.

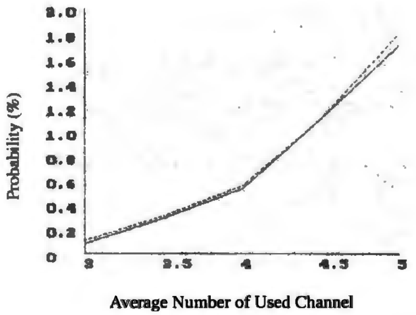
(2) Almost of the existing strategies are suitable for the *light and moderate* traffic, therefore, the selection of strategy is complex and unpredictable. The criterions are an index for choosing the problem-solving strategy.

(3) Through the operation of multi-agent scheme, it was found the probability of blocking and the probability of forced termination are both in a limited range user requirements.

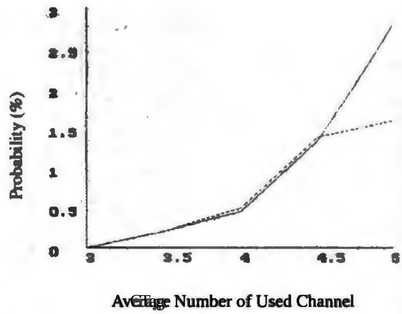
(4) In fact, the complexity and performance are trade-offs. Therefore, how to rapidly switch the different strategies to match our scheme are an important issue in implementation issue.

5. Conclusions

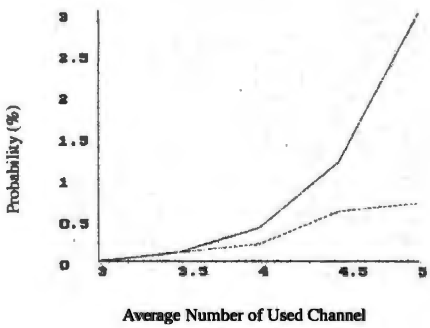
With rapidly growing interest in the area of WPC services in recent years, the PCS channel allocation problem has received tremendous attention. A multi-agent scheme was developed for the PCS channel allocation in our research team. The developed scheme was implemented on a network environment and written in Java CLIPS. Besides, the proposed scheme includes the reasoning



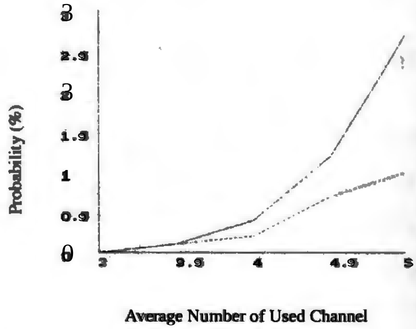
(a) Simple FCA + Guard Channel



(b) Simple Channel Borrowing + Guard Channel



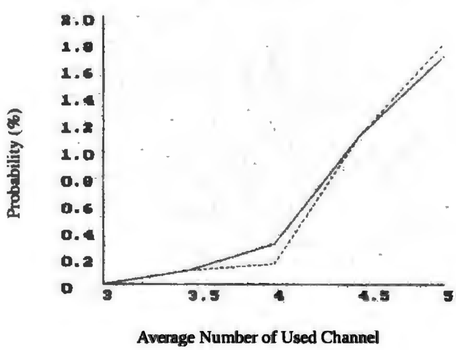
(c) Nearest-Neighbor DCA + Guard Channel



(d) Mean-Square DCA + Queueing Stra

Blocking Probability
Forced-Termination Probability

Figure 7: The performance analysis using the different strategies (sampled figures)



Blocking Probability
Forced-Termination Probability

Figure 8: The performance analysis using multi-agent scheme (sampled figure)

dulates with a two-level control mechanism: local control and meta-control. From the results of test, it was concluded that the proposed approach reached a proper channel allocation plan in PCS environment. In addition, all the heuristic rules and criterions can be satisfied by the plan from the multi-agent scheme and therefore the scheme is a valuable strategy for ubiquitous PCS channel allocation.

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Applications of Acquaintance-Model-Based Co-Operative Agents in Production Planning

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Vladimír Mařík, Jiří Lažanský

The paper describes an implementation of a multi-agent system designed to plan producti... real enterprise – Tesla-TV. The architecture models the relations observed in the plant. The... distinguished four types of agents all utilising the tri-base acquaintance model. Three of them a... employed to model the planning process while the last – the meta-agent – is introduced to sup... the system's behaviour. This approach proves to be highly modular and well attainable.

1. Introduction

Co-operative multi-agent systems (MAS) offer a novel approach to handle those complex syst... where the decisions have to be based on information from various sources of diverse nature [Syc... 95]. Each of these sources can be understood as one agent and the whole system as their commu... – a co-operative multi-agent system.

Multi-agent systems (ideally) consist of a set of autonomous, mutually co-operating elem... agents) which communicate using a specific ACL (agent communication language) [Nwa... Wooldridge 95]. Each agent, as a rule, consists of a *functional body* (usually a stand-alone prog... with a well-defined functionality) and a *wrapper* (which is responsible for agent's engagem... the agents' community). The wrapper contains a *model of the agent's* behaviour. The wrapp... "translates" the inter-agent ACL communication into the instructions for the activity of... functional body and mediates the results of the body activity into the agents' community. The fai... or loss of efficiency of any agent in the considered system should be detected as soon as possible, ...

This is the aim of a meta-agent permanently observing the pre-specified part of the community... the following goals [Zhong 97]:

- to discover a failure of any particular agent
- to re-distribute the load by task re-allocation,
- to create a new agent if appropriate (by copying or 'cloning' some agents).

The meta-agent technology was successfully applied in some of the projects carried out at The Gerstner Laboratory at CTU Prague recently. For instance a simple version of this approach was implemented in the DISCIM multi-agent prototype environment for decision-making [Mařík 96]. Similar ideas have been proposed to solve the reconfiguration problems in distributed control systems.

2. Communication Schemes and Models of Behaviour

Agents' communication is usually one of the most critical aspects of MAS activities. Communication usually causes much more delays than the computational processes themselves. To avoid the delays there are used various communication models such as *broadcasting of task-announcement* or *presence of a central communication agent*. We propose to place an *acquaintance model* [Wittig 95] in the wrappers of individual agents. This model contains information about the capabilities and behaviour of the other agents and the given agent as well. The acquaintance model is used to select the best qualified agent(s) for co-operation. As a matter of fact, these models contain a substantial part of meta-level information about the community. This information is not concentrated in a central agent but it is kept highly distributed across the community.

2.1. The *Twin-base* Acquaintance Model

A specific acquaintance model technique, called a twin-base approach was proposed recently [Cao 96]. This approach suggests organising the relevant information about co-operating agents in two separate information bases in the wrapper, namely in:

- COOPERATOR BASE which has an auxiliary nature and which contains/collects information concerning the other agents. It can provide information on the data and message formats used by the other agents, their addresses, statistics concerning the other agents' efficiency, trust values etc.
- TASK BASE which contains relevant particular information on possible task decomposition and problem solving process in the form of triples

  <Task_Description, Agent, Dependence>.

  Each triple represents a possible allocation of the co-ordination role when solving the given task *(Task_Description)* to one of the agents *(Agent)* as well as a description of a sequence of sub-tasks which have to be solved consequently *(Dependence)*.

Another notation of the triples which was used by the system *ViSe2* [Cao 97] is

$$\langle T_j, A_i, \bigcup^{m}_{k=1} \langle T_{jk}, A_{jk} \rangle \rangle,$$

where T_j denotes the task, A_i represents the agent co-ordinator and the third member of the triple is the decomposition of the task T_j into *m*" subtasks fulfilled by the helping agents.

An integral part of the twin-base model is a revision process aimed at keeping the contents of the bases fresh. This way, the task-base always contains up-to-date information on the current capabilities of the peers. This facilitates directing the co-operation requests to the most suitable agent in the community. As a result, the communication traffic is significantly reduced and the system responses are very fast.

3. The *Tri-Base* Acquaintance Model

The efficiency of a good solution of any task depends on the *current* and *future* availability of agents within the community. The notion of *future* has to be regarded mainly when considering planning and scheduling tasks mentioned in the introductory remarks of this paper. In order to deal with this aspect, we have introduced a *tri-base model* as an enhancement of the *twin-base* model. The novel idea is based on the strict separation of data, and permanent and transient knowledge, which each agent maintains within its wrapper.

3.1. Model Bases

In the tri-base approach, the original CO-OPERATOR BASE has been split into two separate bases: the CO-OPERATOR BASE and the STATE BASE. The CO-OPERATOR BASE keeps rather static information concerning the peers while the STATE BASE is updated very frequently reflecting the changes of the other agents' activities.

In the following we define in more detail what the bases in the wrapper of an individual agent contain.

- CO-OPERATOR BASE - All the permanent data about co-operating agents are located within this base. For any agent *a* there appear three main kinds of data - agent's *a* address, message format and predefined responsibility. Quadruples as follows are proposed to be used:

  $$\langle a, Address_a, Language_a, T_a \rangle,$$

  where agent *a* is a particular co-operating agent, $Address_a$ specifies its physical location such as IP address, port etc., $Language_a$ is its communication format used, and the set T_a specifies responsibilities of the agent *a*, i.e. the tasks the agent *a* is designed to be accountable for.

agent a is accountable for any task $T \in T_a$ whenever it is able to solve the task T itself or by decomposition (decomposition of the task T is suggested in the TASK BASE of the agent a).

- STATE BASE - An agent's STATE BASE does not have to contain information on the entire community. It reports on load and capability of those agents and on tasks that belong to the scope of reasoning of the agent A. The STATE BASE is divided into the *agent section* and the *task section*. This base comprises the non-permanent information:
  (i) The agent section provides data on the status of co-operating agents in terms of their load and reliability. Triples as follows are proposed to be used for this purpose:
  $$(a, Load_a, Trust_a),$$
  where a stands for the particular agent, $Load_a$ specifies its load, and $Trust_a$ is the level of confidence of the agent A into such information. The proper meaning of agent load differs. It can be simply a flag with values of engaged/vacant, a number of requests per time unit, or the agent's agenda, specifying the nearest available time-slot in future. The level of confidence $Trust_a$ may be for instance information on how old the triple is, and/or how frequently does it usually change.
  (ii) In the *task section*, there is stored knowledge related to the actual state of the solution of some tasks. We store information on those tasks, which the agent A is currently solving and on tasks which agents contracted by the agent A are solving as a part of a *SuperTask*, the agent A co-ordinates. If the agent A is interested in another *Task*, an agent B is responsible for, the agent A *subscribes* the agent B for this piece of information. We see *subscription* as a special kind of co-ordination. The quadruple for this purpose may look as follows:
  $$(Task, Agent, Solution, Trust),$$
  where the content of *Solution* specifies the status of the *Task* solved by *Agent*. Information on whether the task has been already solved and on possible time and cost requirements may be included.
- TASK BASE - This structure contains knowledge on possible decomposition of tasks considered. The decomposition can be used to devise various plans how to fulfil a requested task either by means of actions of the agent's body, or by contracting appropriate agents with a request for help. Creation of plans has to be based on fresh information on capabilities of co-operating agents with respect to the relevant goal. As mentioned above, the TASK BASE is divided into its *problem* and *plan* section.
  (i) The *problem* section of the TASK BASE comprises information on possible decomposition of the tasks. Triples as follows are proposed to be used within this sub-base:
  $$(SuperTask, (\{T_i\}, Precedence), Constraints),$$
  This triple claims: "provided *Constraints* are met, the *SuperTask* can be successfully accomplished by performing all the tasks from the set $\{T_i\}$ in such a way that all the time *Precedence* constraints are respected". *Constraints* specify the agents' related

applicability conditions for the given decomposition (for instance, requirement on maximal number of agents engaged in the problem solving or requirements on memory consumption, etc.) If the agent *A* does not decompose the given task (*A* does not delegate it further) and it solves the task itself the triple looks as follows

$$(SuperTask, \emptyset, Constraints).$$

(ii) The *plan* section comprises production rules representing plans how a given task can be accomplished under actual configuration of the considered distributed community. Quadruples as an extension of twin-base triples have been proposed within the philosophy of the tri-base model.

$$(SuperTask, (\{Agent_j, T_j\}, Precedence), Constraints, Trust)$$

If the applicability *Constraints* hold, the agent *A* plans to address the *SuperTask* so that the set of sub-tasks $\{Agent_j, T_j\}$ will be carried out. The agent *A* chooses an appropriate peer $Agent_j$ for each of the considered subtasks T_j. The last argument stands for the Trust of the agent *A* in successful accomplishment of the *SuperTask* using suggested decomposition. How to elaborate the plan is described in Section 'GENERATING PLANS'.

3.2. The Process of Model Updating

Let us review how to maintain the content of the given bases. One option is to use a special agent called *facilitator* devoted to maintenance the content of the agents' bases by *periodical revision*. In idle times it keeps checking agents' load, using the pre-defined information in the CO-OPERATOR BASES and computes the most up-to-date information of agents' current capabilities. This information is to be represented in the form of trust in plans to be used by an agent, so that the most suitable plan gets the highest value.

This approach looses its transparency as soon as we want to deal with parallel processing and shared resources. That is why we search for another solution based on more active role of each agent in the community. An agent can either find out all relevant information itself, or it can get it from contracted or subscribed agents. The first method is considered expensive in terms of communication, as an agent would have to ask the collaborator every time it would go for revision. This revision must be done periodically whereas the subscribing approach makes the agent to revise its information only if necessary. That is why we prefer the second possibility. This approach is to avoid need to rely on a kind of central communication agent, the *facilitator*, that is in charge of updating agents' plans - this kind of comparatively complex reasoning. Responsibility for the *plan section* of the TASK BASE re-computation was shifted to the agent itself. Each agent uses its idle time so that it combines its knowledge in the CO-OPERATOR BASE, the STATE BASE and permanently information on decomposition in the TASK BASE in order to create up-to-date plans. This process will be described later in Section 'GENERATION OF PLANS'.

The planning agent has to be aware of the state of its peers. This is a necessary condition for the success of the suggested approach. To be kept informed the agent could subscribe some agents for information on their state. In this way the agent gets the relevant data directly without being forced to rely on the facilitator. Nevertheless we do not remove the central agent entirely. Our meta-agent is in charge of monitoring an overall load and communication traffic. The main aim of the meta-agent is to reason about these data in order to identify knowledge, which might prove useful for conduct of the community. The meta-agent searches for example for possible mutual relations among some seemingly independent tasks. Such explicit knowledge can significantly extend the strength of the agent community by making it able to cope with more tasks or to solve them more efficiently. The meta-agent can update knowledge in all the bases of the agents.

Let us review the updating process in each of the three bases more carefully:

- TASK BASE: The problem section concerning decomposition of tasks can be understood as permanent. Changes in the problem section reflect the results of the meta-agent's reasoning mostly. These are treated in the Section 'META AGENT'. Updating of the *plan section* consists of checking the available plans and in construction of the new ones – cf. Section 'GENERATION OF PLANS'.
- STATE BASE: Reliable information in the STATE BASE of an agent represents its awareness about the activity of the co-operating agents. This knowledge becomes the central issue of our approach. The STATE BASE as the changing resource of the planning process has to be well updated and maintained. Any agent contracts all of its collaborators from the CO-OPERATOR BASE and subscribes these for reporting on their status. Every time the state gets changed the collaborator sends a message to the original agent in order to let it know that the STATE BASE is to be updated.
- CO-OPERATOR BASE: There are basically permanent data regarding collaborating agents stored within the CO-OPERATOR BASE. These do not require any often updates. The meta-agent that is in charge of monitoring the agent's operation may detect some of suspicious irregularities or changes in its activity. Either loss or enhancement of an agent capabilities are viewed as examples. So the meta-agent is supposed to update the CO-OPERATOR BASES of the agents.

3.3. The Community Lifecycle

The multi-agent community may be in charge of a number of parallel problem-solving projects (tasks). There are three distinct stages of the community operation with respect to a single project. The system may be engaged in PLANNING, RE-PLANNING, and EXECUTION.

- PLANNING - When planning, the community creates a plan and elaborates an estimation of resources (time, cost) requirements under supervision of a single agent responsible for the given task.
- EXECUTION - When executing, the system triggers the activity stored in the TASK BASE of particular agents. Occasionally re-planning has to be evoked if an obstacle in the execution appears.
- RE-PLANNING - When re-planning, each agent reacts to any of relevant changes within the STATE BASE and thus makes the plan the most up-to-date.

3.4. Generation of Plans

Suppose an agent *A* is in charge of a *SuperTask*. The agent can either

- use an existing plan stored in the ***plan section*** of its TASK BASE or
- elaborate a new plan using its own methods and skills.

In the latter case the agent *A* starts with problem knowledge found in the ***problem*** section of TASK BASE. Here it finds a piece of general decomposition knowledge for the considered *SuperTask* in the form

$$\langle SuperTask, (\{T_i\}, Precedence), Constraints\rangle,$$

where $\{Ti\}$ is the set of tasks the *SuperTask* is to be decomposed into.

For simplicity let us suppose that the set *Precedence* is empty. We will return to the more general case later. The agent *A* consults its CO-OPERATOR BASE in order to detect the possible collaborators for all the tasks in $\{Ti\}$. The agent *A* is supposed to find a good match for each task from the $\{Ti\}$, i.e. to complement each task Tj with the name of an agent Aj that is ready to cope with the particular task. The requested result is a set of couples $\{(Aj, Tj)\}$ meeting the following requirements:

(i) For each task Tj the agent *A* finds an agent Aj such that there is a $\langle Aj, \_, \_, \{T_k\}\rangle$ stored in the CO-OPERATOR BASE of agent *A* and $Tj \in \{T_k\}$.

(ii) For the set $\{(Aj, Tj)\}$ the applicability *Constraints* get checked. Only those couples which meet the constraints, are evaluated further.

(iii) The evaluation of the trust *Trust* is carried out under consideration of the $LoadAj$, $TrustAj$ of the agents Aj as parameters, where $\langle Aj, LoadAj, Trust_{Aj}\rangle$ is contained in the STATE BASE of *A*. Just those couples $\langle\{(A_j, T_j)\}, Precedence\rangle$ with best evaluation are considered and they form possible plans:

$$\langle SuperTask, Agent, (\{(A_j, Tj)\}, Precedence), Constraints, Trust\rangle.$$

---

* The symbol '_' stands for an anonymous variable the value of which is not relevant

Trust can be either minimal trust of all the agents the task is delegated to, average, or weighted average. The quadruple with the highest trust *Trust* is viewed as the actual plan.

If the content of the STATE BASE (the agent section of which is an important resource for the plan construction) gets updated, *Trust* is to be re-computed and each of quadruples is to be re-evaluated consequently. This kind of re-planning activity makes the plan the most up-to-date and bridges the planning and execution stages of the problem solving process.

Now let us consider the general case, where precedence constraints for some tasks apply. One possibility how to address this is based on the idea of planning without any scheduling mechanism, which is one of the options offered within the tri-base model. In this case we substitute planning by the negotiation process. An agent simply has to find out when the required preceding task, specified in the precedence constraints, is due to. Instead of contracting the responsible agent, it just consults its own STATE BASE - *task section* in order to find out the time when it can start planning the task considered. If no such information is found in the STATE BASE, the agent finds an appropriate collaborator in its CO-OPERATOR BASE and *subscribes* it for such information.

If the agent is to delegate the task T_j further on to other agents it has to let them know the starting time given by the preceding task. This piece of information is usually stored in the *task section* of the STATE BASE.

The suggested approach can obviously result in plans, which are far from optimal. This can happen namely if there are some tasks in the community, which can be accomplished by a single agent only (this agent becomes a bottleneck of the solution). To avoid it more sophisticated algorithm of partitioning the set of subtasks with respect to *Precedence* constraints has to be elaborated. Our solution tries to create the relevant part of the partition within the limits generated by *lazy* and *eager* strategies [Mařík 98].

3.5. Communication Traffic

Using the tri-base acquaintance model within the wrapper of each of the agents significantly reduces the need of inter-agent communication. As it was seen above, substantial part of negotiation processes is replaced by planning carried out internally - without any vast communication with the others - by the agents responsible for the given task. Instead of the necessity to communicate, the agent consults its STATE BASE to find the best peer to co-operate.

Four kinds of messages used in the inter-agent communication remain:

(1) When the plan starts to be executed, the task co-ordinator sends requests to the colla[illegible] agents to carry out their jobs. The task co-ordinator receives messages confirming "the jo[illegible] done" later. These messages up-date the task section of the STATE BASE of the task co-ordina[illegible]
(2) In the case, some information about the other agent (like the processing time or readin[illegible] start) is missing, a message subscribing for the corresponding answer is sent out. Th[illegible] messages are used to certify information required for the precedence handling.
(3) When the state or capabilities of an agent are changed, the agent itself sends this inform[illegible] change the content of the STATE BASE or CO-OPERATOR BASES of its peers.
(4) The messages from the meta-agent represent a special category of messages, which is anal[illegible] in more detail below.

Some of the messages noted in the points 3. and 4. may be transmitted to the entire communi[illegible]

4. ProPlanT System

TESLA-TV is a Czech manufacturing enterprise assembling TV transmitters, FM transmitters [illegible] passive elements. The manufacturing process within TESLA-TV can be classified as a proj[illegible] oriented production because design-related activities play a dominant role in the proc[illegible] production. There is no assembly line used within the plant and it is very difficult to formal[illegible] production as a continuous process. Consequently, rather than planning and simulation of a flow [illegible] semi-products to be assembled, there is a need for an information technology solution which [illegible] facilitate simple planning and subsequent optimisation of the unique final product manufact[illegible]

Currently ill suited information flows, lack of communication among particular production u[illegible] and far from full utilisation of available information processing solutions is what makes all o[illegible] production difficult to understand, model, plan and consequently optimise. Attempts to creat[illegible] global, "monolithic" software solution, no matter how well hierarchically structured, have fail[illegible] There is a set of diverse software tools (from our point of view legacy software systems) used in [illegible] plant currently to solve the same partial tasks. On one hand it is crucially important to integ[illegible] these partial solutions and on the other hand the flexibility and frequent changes in the produc[illegible] facility inevitably require highly distributed solutions. We have proposed to apply the multi-a[illegible] approach for this purpose.

ProPlanT – PROduction PLANning Tool is a multi-agent system for project-oriented produ[illegible] modelling and simulation. The test-case of the project is the TESLA-TV plant mentioned abo[illegible] We have identified a number of distinct information and processing units within the factory, nam[illegible] sales department, project department, production management department, purchase department[illegible] research and development department, store department, construction and technology departm[illegible]

IT department, marketing department. The system architecture resulting from the analysis is based on the following principles:

(1) Any detailed project plan/schedule is prepared as a result of information exchange among a finite number of agents (each agent corresponds to one or more company units).

(2) Each agent in the ProPlanT belongs to one of the following disjunctive sets of agents:
PRODUCTION AGENT – each working unit such as production or store department is represented by this the *production agent* (PA) that models its behaviour/performance.
PROJECT MANAGERS – the production management department is represented by a set of independent autonomous *project managing agents* (PMAs).
PROJECT PLANNERS – the *project planning agent* (PPA) simulates the functions of the project department as well as the construction and technology department.
META-AGENTS – the meta-agent (MA) collects information on the activities of the other agents in the system, evaluates the data and tries to utilise the obtained results in order to increase efficiency of the overall system.

Agents are organised into a – in some sense – hierarchical structure: The outputs of the production planner agent (PPA) appear first in the form of a set of tasks to be carried out and a set of precedence constraints for these tasks. Later, PPA structures the original set of tasks into a sequence of task groups in such a way that each group contains only those tasks which can be processed in parallel without violation of the fixed precedence constraints (see later for more details). The tasks from one group (those which can be fulfilled in parallel) are sent out to relevant PMAs according to the PMA specialisation. PMA solves the task it is asked to by further dividing it into jobs, which are mostly assigned to PAs.

(3) A tri-base model can formalise three used agent types, namely the PPA, PMA and PA. The *co-operator-bases* contain permanent or semi-permanent knowledge on production facilities (their structure, transportation paths, capacity, etc.) as well as knowledge how to organise and plan projects. Part of the co-operator-base knowledge may be of heuristic nature. The *state-bases* contain temporary information on load, processing time, trust, etc. The *task-bases* are expected to store intermediate results of the planning process, i.e. the directives how to plan tasks and jobs.

4.1. Project Planning Agent

PRODUCTION PLANNING AGENT is in charge of project planning. It is supposed to construct an exhaustive, partially ordered set of tasks that need to be carried out in order to accomplish the given project. He contracts appropriate PMAs. If viewing the project planning as '*divide and conquer*' kind of philosophy, PPA *divides* in order to facilitate PMA agents to *conquer*.

The problem of configuration is classified as a synthesis-type of activity of explosive combi[...] nature. Configuration is usually seen as a problem of assembling elements of the desired sy[...] together in such a way that internal logical constraints are not violated. Very often some kin[...] optimisation criteria, such as price or efficiency, is considered. Here we distinguish betwee[...] and *soft* constraints. Whereas the former must not be broken, the extent to which the latter i[...] obeyed is the subject of further optimisation. The applicability constraints specified in paragr[...] are instances of the *hard* constraints.

We have used proof planning for formalising the knowledge as mentioned above. The proof pla[...] follows the inference knowledge when considering the object level knowledge and utilisi[...] possible heuristics. The planner manipulates the meta-description of problem solving pro[...] and plans the course of problem solving. Than it checks the *soft* constraints and executes all of [...] planned procedures. Let us comment on each of stages in the proof-planning like fashion.

4.2. Project Managing Agent

The scheduling activity of PRODUCTION MANAGING AGENT can also be described in terms of the tri-base model. The knowledge on how to decompose the tasks into jobs is contained in the operator-base, the current situation in the manufacturing workshops is represented by the [...] within the state-base and the intermediate results of the PMA planning activity are stored in [...] task-base in the form of quintuples:

$$\{(T_r, PMA_s,\ S = \{(J_{rs},\ PA_{rs})\}, C, V)\}$$

where the production management agent PMA_s manages the solution process of the task T_r [...] carrying out the sequence S of jobs under the limitation of the applicability constraint set C and [...] accompanying trust parameters V. The PMA_s decomposes each task in elementary jobs, each of them being carried out by just one PA belonging to the scope of PMA_s's subordination. To be [...] precise: The tasks "accepted" by PMA_s are decomposed into jobs that are contracted to [...] "subordinated" PAs if possible. If the task or its part cannot be carried out by the "subord[...] PAs, the "non accepted" part of the task (a subtask) is broadcasted to the other PMAs with a [...] request.

4.3. Production Agent

PRODUCTION AGENT simulates the duties of a foreman on the shop floor level. It is suppo[...] manage a parallel job scheduling on a number of machines. The knowledge stored in its [...] operation-base enables it to schedule each relevant job as either a single operation on a s[...] machine or as a sequence of operations carried out on (possibly) different machines. Each [...]

schedule is equipped by an additional piece of information describing the time and costs of carrying the job under current manufacturing circumstances. This additional information is computed from the data in the state-base.

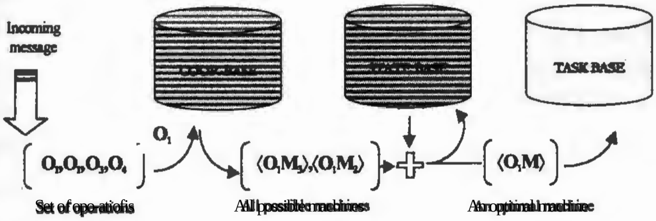

Figure 3 – Model of PA activity

Example - In ProPlanT, the tri-base model has been used for planning the production on the lowest level as a model of behaviour of PAs. It is necessary to distinguish between preliminary planning and operational planning (scheduling) applied just before starting the manufacturing process. During the preliminary planning acceptable quintuplets are created and inserted into the task base. At the operational planning, the currently most appropriate quintuplets in the task-base are chosen.

OPERATION	MACHINE	TIME	COST
093390063000	16611	15	96
023460340000	16315	10	0.2
023400735000	09615	10	0.4
023400735000	16517	10	0.6
023965018000	16313	5	0.3

Table 1 – The table represents a fraction of the co-operator-base of the PA agent, which simulates an activity of the department no. 685 (a big part assembly line), in TESLA-TV. There are 5 machines to carry-out 4 kinds of operations. A job 023400735000 (frequency mixer installation) can be performed taing either 09615 or 16517 machine. Both are equivalent time-wise but using the former one is cheaper.

MACHINE	CAPACITY	TRUST
09615	10	0.904
16315	45.2	0.811
16517	8	0.862
16611	0	1.00
16313	22	0.989

Table 2 – The table represents a fraction the state-base of the PA agent, which simulates an activity of the department no. 685 (a big part assembly line) in TESLA-TV. The capacity column shows the load of the machine in terms of number of time units needed to finish its actual job. In this case, the 16611 machine is vacant.

While planning, the PA receives sequence of jobs to be carried out from the PMA. That means that the decomposition of the task into jobs is performed by PMA using its co-operator base. There are two options:

- One job represents just one operation in one machine.
- One job requires a sequence of operations carried out on the same or different machines.

In the latter case, the PA decomposes the job into a sequence of operations using the content of co-operator-base. This process is strictly analogous to that of decomposing tasks into a sequence of jobs on the PMA level.

Thus, without any loss of generality, it is possible to consider that one job is carried out by just a operation (and this is the case, which just occurs in TESLA-TV factory). The request message to a PMA (a sequence of jobs = a sequence of operations) is compared to the content of the PA's co-operator base and the state base. As a result an optimal couple <Operation, Machine> or a set of acceptable couples (for each operation) are shifted to the task base in the form of corresponding quintuple or quintuples.

Samples of the contents of both, the co-operator base and the state base are shown in Tables 2,3. During the operational planning the pre-prepared quintuples already stored in the task-base are matched to the actual data located in the state-base. Only the best fitting quintuples (=local plans) are included into the final plan and the required capacity of the corresponding machine is claimed.

4.4. Meta-Agent

The introduced meta-agent is expected to be an entity that extends the system in order to improve global behaviour. It proved to be useful especially during run-time operation of a multi-agent system. Its role in planning has yet to be clarified. So far, we have identified the following contributions:

- Discovering agent failures and providing instructions on how to continue in both the negotiation and/or manufacturing processes (the meta-agent can update arbitrary PMA's co-operator base by adding and/or removing some of its elements).
- Updating the PMA's state-base variables by exploring the information gained through the monitoring of the agents' load and message traffic. In this way, the so-called capability revision process [Cao 96] of PMA's task-base is evoked.
- Updating the PPA's and PMA's co-operator-bases with respect to recent changes among PMAs and their subordinated machines.

4.5. Implementation

The PPAs were implemented in LPA Win-Prolog 3.2. The PMAs and PAs were implemented in Optima++, C++ developing environment, and the data structures were captured in Sybase

Anywhere. The inter-agent communication uses KQML convention with the message content in the KIF format.

5 Conclusions

The tri-base formalism for describing an agent's activity seems to be suitable for description of the activities of multi-agent systems for production planning in the case of project-oriented manufacturing. The particular contents of the bases for different types of agents are shown in Table 3. All of three instances of co-operation-bases contain semi-permanent knowledge needed for their activity. The state-bases contain complementary actual data e.g. on load, costs, and subjective trust in activities of some other agents. Typically, the contents of the task-bases are created during the planning process. The quintuples in the agents' task-bases then direct the way to reach the main goal, i.e. creating the production plan schedule. The result of the planning process (the PAs' schedules) is stated in the PAs' state-bases and is used later for the management/control purposes in the manufacturing process.

AGENT	CO-OPERATOR BASE	STATE BASE	TASK BASE
PPA	{(PMA, T)} & decomposition rules	{(PMA, load, trust)}	$\{(P_j, PPA, T=\{(T_{j,k})\}, P, V)\}$
PMA	{(PA, J); (PMA, T)} & task decomposition rules/schemas	{(PMA, load, trust)} {(PA, load, trust)}	$\{(T_i, PMA_i, S=\{(J_{i,n}, PA_{i,n})\}, C, V)\}$
PA	{(Operation, machine, time, cost)} & rules for selection of optimal touple (operation, machine)	{(machine, capacity, trust)}	$\{(O_j, PA_j, machine_k, V, C)\}$

Table 3 – Content of agents' bases in ProPlanT

The clear separation of the three types of bases enables a very simple maintenance and up-date of the available knowledge and data. It also enables much simpler integration of legacy knowledge/data structures of a diverse nature. There is one very interesting feature considered in the ProPlanT; the generated detailed plans are stored in a highly distributed way; their parts are stored in the autonomous agents. There is no central, monolithic plan available. This fact enables minor change in the "local" plans whenever it is appropriate without any change of the overall plan structure. Once created, the plans can be checked/up-dated with respect to the current situation (current loads, trust measures, machines available etc.) whenever it is appropriate. As analogy to operational planning, this up-date is obligatory just before starting the manufacturing and can be carried out on both global and local levels.

The ProPlanT is a modelling system for production planning. The execution of the plan is out of the scope of this planning activity. It might be expected that during the plan execution our agents are in a slightly different mode of operation. In this case, the similar tri-base formalisation can be applied, but the bases then get a different content. The co-operator-bases contain the quintuplets of already pre-prepared plans, the state-bases information about the current loads, costs, trusts etc., and in task-bases information on the current status of the plan execution is stored.

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Adaptive Protocol Stacks For Multimedia On The Internet

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Abstract

This paper presents the Real-time Wide Area Network Dissemination Architecture Protocol (RWANDA) which dynamically configures multimedia protocol stacks to support a wide range of application requirements and to increase performance. It overcomes synchronous limitations by providing an asynchronous group communication model. Applications only pay for required quality of service (QoS) such as multicast, virtual synchrony and encrypted communication. Programmers can request qualities of service such as reliable multicast, virtual synchrony, encrypted communication and a protocol composition framework that extends to incorporate yet unsupported communication protocols and qualities of service.

iBus, is a distributed object framework aimed at supporting intranet applications such as content delivery systems, groupware, fault-tolerant client-server systems and multimedia applications. iBus is built on top of an asynchronous group communication model thus providing support for multimedia QoS parameters. It is within this framework that we have developed the Real-time Wide Area Network Dissemination architecture Protocol (RWANDA). In RWANDA, information sources use channels to disseminate information to a potentially large and changing set of channel subscribers, analogous to cable TV.

Key words: Distributed systems, multimedia, middleware, continuous media.

1. Introduction

Recent developments in data communications are dominated by advances in high-speed networking and distributed multimedia applications. Multimedia applications increase the set of requirements in terms of throughput, end-to-end delay, delay jitter, synchronisation. These needs may not all be directly met by the networks; end system protocols enrich network services to provide the quality of service (QoS) required by applications. Obviously, fixed end-system protocols are not able to support the wide range of application requirements on top of current networks (ranging from modems up to gigabit networks) without adding overhead in form of unnecessary functionality for multiple combinations of application requirements and networks.

The Aim of the RWANDA paradigm is to improve this situation by configuring end-system protocols to cater for the differing media within multimedia. Configuration serves to support a wide range of application requirements and to increase protocol performance by decreasing protocol complexity.

1.1 Isochronous Traffic Characteristics

An isochronous application must include some time-critical element such as a media stream, i.e. a continuous stream of bits with strict time dependencies between those bits. Streamed applications are essentially one-way flows of information such as broadcast or on-demand video and audio services.

Isochronous Internet applications have quality of service (QoS) requirements that must be considered on an end-to-end basis [18]. In taking an end-to-end perspective, end-system and network capabilities are equally important in delivering the QoS support required at the application layer. For media requiring timely guarantees, application designers are primarily concerned with temporal properties such as delay, jitter, bandwidth, synchronisation and reliability properties such as error-free delivery, ordered delivery and fairness.

Audio quality is highly sensitive to jitter, and the watchability of video is sensitive to available bandwidth [1]. For lip synchronisation, audio and video streams need to be synchronised to within 80-100ms for skew to be imperceptible [10]. Packets are effectively passed automatically through to the presentation device. Interpretation of the delivered information is left to human perception; because humans are far more tolerant than computers, lost packets are likely to be perceived merely as a temporary quality reduction. Nevertheless packet loss is still a significant problem for isochronous interactions. For example, since a typical packet size is generally above the threshold for audible loss (~20ms), the loss of a single audio packet can be irritable to the receiver. Resource reservation protocols are an attempt to resolve these difficulties by allocating resources prior to communication.

Multimedia has varying optimal transport methods. The traditional methods employed by transport protocols is to ship all data through identical protocol stacks. An id[illegible] method would transport each media thro[illegible] an optimised stack constructed solely for [illegible] medium allowing improved multim[illegible] Quality of Services to be achieved even [illegible] run-time.

1.2 Distributed Objects

An Object is a programming abstractio[illegible] encapsulates data and behaviour. Distri[illegible] Objects are accessed over networks wh[illegible] location of the object need not be importa[illegible] its users. Objects with their nat[illegible] combination of data and behaviour and[illegible] separation of interface from implementa[illegible] make a neat useful package for distribu[illegible] data and processes to end-user applicat[illegible]

In a Distributed Object environm[illegible] application development and manage[illegible] simplified because clients do not need t[illegible] know which languages objects [illegible] implemented in, what hardware or operati[illegible] system they run on, and so forth. Th[illegible] fundamental idea behind interoperable obj[illegible] is to cross existing boundaries betw[illegible] operating systems, address spaces, mach[illegible] and languages. A technology that cros[illegible] machine boundary must also locate the serve[illegible] object, establish communication with it, [illegible] up the request and send it off, then wai[illegible] results and return them to the appli[illegible] These are only the most basic require[illegible] Then come the requirement for secur[illegible] versioning, name resolution and a host [illegible] other details inherent in distributing obj[illegible] across a network. Only object techno[illegible] that cross the machine boundary can be t[illegible] called distributed object technologies.

1.3 QoS Requirements

The traditional relation between service u[illegible] and service provider is a simple contra[illegible] Service using applications specify th[illegible] requirements by a target value [4,5] or target range [6] for QoS parameters. Service providers offer QoS in a best-effort manner such as OSI TP4 or in a guaranteed manner such as ST-II, or reject the service request. Multiple renegotiations might be performed to find a satisfying and supported QoS.

From our point of view, this fixed negotiation scheme is not appropriate for complex multimedia requirements. Generally, applications have only a very limited knowledge on available resources, network services, and end system load, and they may change drastically [8]. Furthermore, applications want to attain more than one (possibly contradicting) objective such as high performance and low costs. New QoS definitions in [3] and [7] introduce some flexibility for the service provider.

1.4 Generic Transport Stack Limitations

Multimedia is composed of varying types such as audio, video, text, control information, etc. Within these types, exists a multitude of formats such as JPEG, MPEG etc. Take the example of a conference application, where control information and files need to be transmitted alongside audio and video. The control information such as who has floor control and files need reliable transport guarantees, whereas the audio and video may be transmitted with a differing QoS. Using an identical protocol stack to cater for all these transport types is not an ideal scenario.

Traditional transport protocols transport the media types through the same stack. If a video file is filtered through the same stack as an audio file, the video data will have to adopt the packet size allocated to the audio file. Audio in general runs more efficiently with smaller packet sizes. Isochronous Multimedia traffic can tolerate some loss however data that misses its expected delivery time is of no use. Therefore it is more efficient to lose smaller packets than larger packets. However, smaller packets demand increased header processing in routers. Small packet sizes are not optimal for graphical data. A more efficient method would construct optimised protocol stacks for each of the media e.g. audio, text, video. Maximum benefit would be achieved if this could be implemented at run-time to cater for the applications particular preferences.

2. The RWANDA Protocol

The RWANDA protocol caters to large-scale isochronous wide-area multimedia applications. RWANDA is based on our ideal of an transport protocol for dissemination-oriented communication providing a basic service that supports multicast streams, with incremental extensions and specialisation's to support conversational and request-response communication as part of the same base protocol mechanism.

RWANDA overcomes;

- the blocked synchronous foundation by providing an asynchronous foundation;
- the TCP and generic protocol stack limitations by providing a tailored dynamically composed transport protocol
- the unicast limitations by providing a multicast communications model.

Java has been chosen as the implementation language primarily due to its platform independence as we are dealing with a heterogeneous environment. Java's extensive networking facilities, ease of use and automated garbage collection aid system development. Java also allows the construction of a system without platform specific extension libraries such as dynamic link libraries which must be in place before

communication can take place in may other frameworks.
RWANDA builds upon the iBus framework [12] which has an asynchronous foundation suitable for supporting isochronous applications. iBus is a software bus which supports intranet applications such as content delivery systems, groupware, fault-tolerant client-server systems and multimedia applications. iBus has also been designed to cater with large scale information dissemination such as on the Internet. The RWANDA protocol is outlined below and the implementation of a real-time multimedia dissemination protocol is outlined with reference to problems that RWANDA is intended to overcome in an application of this nature.

This following section describes our design at a high level. In our design, protocol functionality is provided to an application by two interacting components – a protocol library that is linked into the application and a network I/O module that is co-located with the network device driver. The network I/O module is the Network Part of Figure 1. We decline to further discuss the I/O module in this paper.

The library contains the code that implements the communication protocol. For instance, typical protocol functions such as retransmission, flow control, check summing etc., are located in the library. Given the timeout and retransmission mechanisms of reliable transport protocols, the library typically would be multithreaded. Applications may link to more than one protocol library at a time. For example, an application using TCP will typically link to the TCP, IP and ARP libraries.

2.1 Protocol Elements

The protocol elements (objects) are illustrated in Figure 1. These are chann senders, receivers, postings and filters.

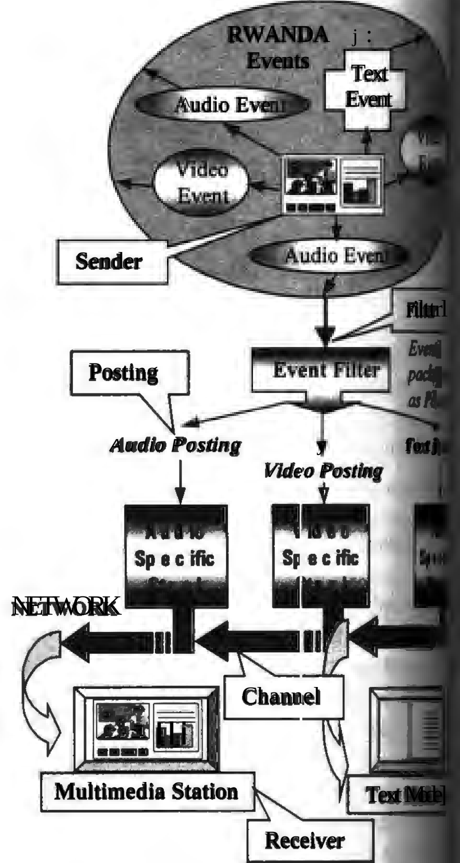

Figure 1 - RWANDA Element

Channels

Channels are a multicast medium into wh sender applications push objects, and which receiver applications can subscribe receive those objects. A channel maps into IP multicast group or a point-to-point UDP connection. Uniform resource locators is used for naming channels. These are den by URLs such Videoplayer://227.34.3.63.

Senders

Senders push Java objects via one or more channels. To transmit a posting, the push operation is invoked with the appropriate URL and posting. The object will be transmitted by IP multicast or unicast depending on if the URL denotes a multicast address. Push communication is in one direction from Sender to Receiver and non-blocking.

Receivers

Receivers subscribe to channels to receive Java objects such as audio/video postings. Receivers may also explicitly request data from a receiver by issuing the *pull* operation. *Pull* however, is two-way and blocking, analogous to RPC.

Postings

All data to be pushed/pulled via a channel is encapsulated into a *posting* object. These are serializable Java objects sent through channels. The sender serialises an object by traversing its references to other objects in the object graph recursively to create a complete serialised representation of the graph. At the receiver, the object graph is de-serialised and reconstructed enabling user defined objects to be communicated without requiring marshalling code.

Filters

Filters extract different media types creating suitable run-time protocol stacks to enable streamlined transport communication to be invoked. Filters are responsible for re-assembling the flows at the receiver.

A comparison could be made with the CORBA Event Service [13]. In summary, an event as defined by the CORBA Event Service is simply a parameter in a standard CORBA method invocation, with options available for multicasting and buffering message parameters. The programmer wanting to use this service is still faced with the problem of how to locate events of interest, how to advertise new kinds of events, how to match patterns of events, and how to create and maintain networks of event channels to perform matching. Thus, the CORBA Event Service provides only a small subset of the capabilities needed in an Internet-scale event observation and notification facility.

2.2 Dynamically Composable QoS Stacks

Central to providing an adaptable QoS is the ability to maintain multiple protocol stacks. A protocol stack consists of a linear list of protocol objects and represents a quality of service such as reliable delivery or encrypted communication. The framework provides the services necessary for supporting new communication protocols and qualities of service. RWANDA consists of a set of Java classes for representing Uniform Resource Locators, protocol stacks, the framework API and posting objects.

Dynamically composable protocol stacks overcome the limitations imposed by generic protocol stacks. A dynamically composable protocol stack allows optimisation for particular traffic. The RWANDA framework allows protocol stacks to be composed dynamically at run-time, creating a flexible architecture suited to client application needs.

The diagram in Figure 2 depicts three protocol stacks. The text stack is a stack that addresses applications that need to communicate reliably through private channels. CRYPT is in charge of encrypting and decrypting postings on the fly. NAK takes care of retransmitting lost postings and of flow control. The stack is composed as follows.

```
Stack text = new stack
(„CRYPT:NAK:IPMCAST");
```

This QoS could also be intended for applications that multicast financial information such as stock quotes or trading recommendations over an intranet.

The video protocol stack is suited for applications that require that postings be comminicated as efficiently as possible. Large postings that do not fit the UDP datagram are fragmented and reassembled by the „FRAG" protocol object. This stack is composed as follows:

```
Stack video = new stack
(„FRAG{size^2048}:IPMCAST");
```

For example, if a stack is created out of the QoS „FRAG:IPMCAST" then a posting will first reach the FRAG protocol object. FRAG is in charge of fragmenting large postings into fixed-size datagrams that can be sent through an IP multicast socket. FRAG then passes the datagrams down to the NAK (negative acknowledgements) object. NAK caches each datagram in case it is lost on the network and that the receiver requests its transmission. Finally, IPMCAST submits the posting by IP multicast communication.

2.3 Mixed Media Filtering

Distinct media formats deserve distinct transportation treatment. RWANDA filters the data depending on the source data stream e.g. audio (Microphone), Video (Camcorder) or text (File transfer) and composes one of a library of protocol stacks suitable for transmission of the media as illustrated in Figure 2.

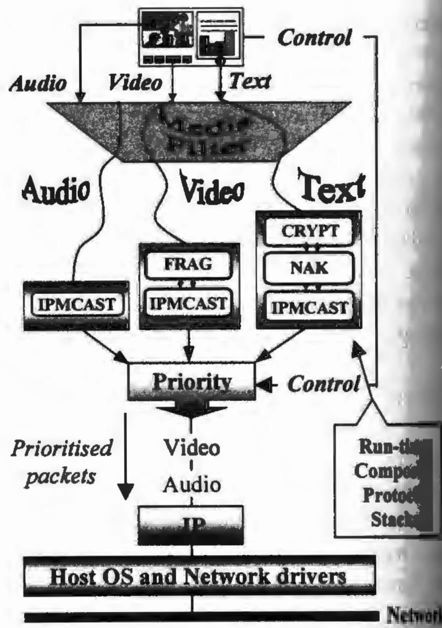

Figure 2 - Filtering of isochronous media strea

The result is that separate streams from t same application are multicast to the same group address, and filters recompose th streams into an integrated applicatio Protocol stacks can be compiled as late run-time depending on the need for adaptability. There is a noticeable cost fo stack reconfiguration but it is a reason overhead if it can be amortised over multiple subsequent data exchanges. Stand recognised objects are audio, video or text, objects. These can be expanded to inclu more objects and specialised media typ within these groups.

RWANDA will provide a reconfig plug-and-play network protocol architec intended for adaptive applications. Th architecture revolves around the notion of protocol stack. Such a stack is constructed from modules, which can be stacked and stacked in a variety of ways to meet communication demands of its applicat RWANDA'S protocols implement, amo others, basic sliding window protoc fragmentation and re-assembly, flow-control, encryption and message ordering. Run-time protocol stacks are created according to the QoS string specified in the constructor. To transmit a posting over the network, the `void push (iBusURL url, Posting p)` operation is used. The URL denotes the channel on which the posting object will be transmitted by IP multicast or unicast, depending on whether the URL denotes a multicast address or not. Push is in one direction from the sender to the listeners, and non-blocking.

For registering an interest in the postings that are pushed and pulled to and from a channel, applications issue the `void subscribe (iBusURL url, Receiver rcv)` operation.

When a push request is received on a channel denoted by url, the framework passes that posting to the Receiver object by invoking its `dispatchPush` operation. On a pull request the `dispatchPull` operation is invoked. The posting that is returned by `dispatchPull` will be transmitted back to the client that has issued the pull request. An application can subscribe multiple receiver objects to the same channel, and also subscribe the same receiver object to multiple channels.

2.4 Rwanda Removes The Server Bottleneck

A request-reply model is where each interested party separately polls the source for updates. This can lead to the sender becoming a bottleneck. The RWANDA protocol overcomes this by the use of channels. Here the receiver is decoupled from the sender. The central abstraction is a set of communication channels into which sender applications push objects, and to which listener applications subscribe to receive/pull those objects. The framework is responsible for transmitting objects over the network to the subscribed listeners. With increasing scale, dissemination actually saves bandwidth because it eliminates the flood of duplicate requests and responses when multiple clients all request the same information.

A channel maps into an IP multicast group [15] or into a point-to-point UDP connection. Multicast communication is predominant since it offers higher flexibility, allowing applications to be relocated from one machine to another and to distribute data from one sender to many receivers efficiently also catering for fast and slow receivers. URLs are used for naming channels.

3. Measurement Methodology

As RWANDA is built upon a distributed object framework, we thought it best to compare our stacks against a the popular CORBA framework. We choose the VisiBroker for Java Orb [21] – which is one of the more common Orb implementations at present.

One of RWANDA'S strengths is its ability to dynamically create protocol stacks. Java enables RWANDA to dynamically invoke objects on remote servers which the server has had no prior knowledge of. This is achieved by Java's pass-by-value mechanism which allows the objects contents to be serialised and transported to the server and invoked within the servers Java virtual machine. At present, CORBA can only pass by reference. There is a RFP in progress at the moment. To obtain the pass-by-value timings for the CORBA implementation, we had to use smart proxies and convert the objects to strings, serialise and transmit across the ORB where the strings must be converted into object references and the same procedure repeated for the result.

In our first test, we hope to prove that RWANDA provides a transport system which outperforms CORBA when it comes to passing objects to remote servers. As CORBA has no pass-by-value mechanism, the object must be wrapped, serialised and transmitted.

In the second series of tests, we wish to demonstrate the benefits of dynamically adapting a set of protocol stacks to varying conditions in network performance so as to obtain maximum throughput.

All the measurements are conducted on 200mhz Pentium PC's with 32mb connected to a 10 Mb/sec Ethernet. We measure throughput by pushing events into an event channel which has a buffer of 100 events, without the event channel losing events. The latency between a CORBA stack and a RWANDA stack is measured by recording the machine's high resolution time, pushing an event, recording the high resolution time when the event is received by the consumer and then repeating this entire measurement after a short delay. The difference in the two times is the latency.

In Test 1, we passed a QuickSort object containing various sized lists from 100,000-1,000,000 integers as a parameter to a compute() method. We were measuring the pass-by-value performance of the two systems. We found CORBA to be approximately twice as slow as RWANDA'S pass-by-value mechanism as illustrated in Figure 3. The reason for RWANDA being faster is that it eliminates the need for the middleman – the ORB. As the object is serialised, it is also being transmitted over the wire to the server and serialised on the other end.

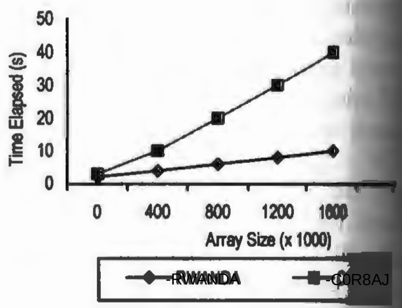

Figure 3 – Time Elapsed Vs Array Size for RWANDA Vs CORBA

Figure 4 displays the results from test 11 which dynamically reconfigures the protocol stacks through reflective methods in an attempt to provide optimal conditions. We compare the basic IP multicast stack (no scheduling) to a FIFO scheduler. In each case, we have 6 clients, 3 of them requiring seconds of processing every *t* seconds, and the other 3 requiring 6 seconds of processing every *t* seconds. We adjust *t* to change the targeted CPU utilisation. Initial tests have shown that FIFO scheduling performs the best. Basic IP Multicast actually outperforms FIFO at lower CPU utilisation's since enough capacity is available however in increasing conditions, performance of the Basic IP Multicast stack deteriorates. This is an area where we hope to dynamically alter the protocol stacks to provide for optimal scheduling policies such that we achieve the optimal configuration of Figure 5.

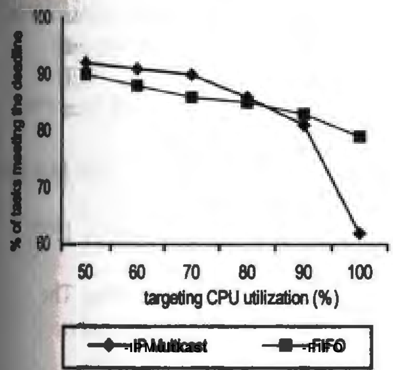

Figure 4 - Performance of scheduling policies

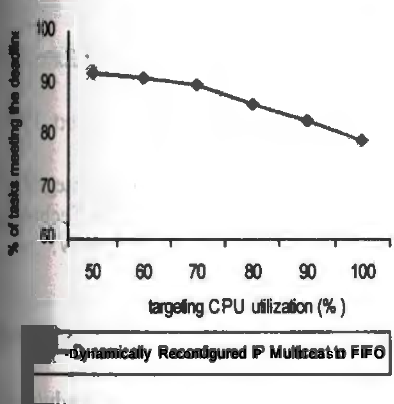

Figure 5 - Stack Throughput after Reconfiguration

We plan to use the adaptive capabilities of RWANDA to build collaborative chat applications operating in a dynamic, heterogeneous environment. Using the reflective capabilities of RWANDA, it will use media specific communication protocol stacks adapting to varying network conditions.

4. Conclusion

Recent developments in data communications are dominated by advances in high-speed networking and distributed multimedia applications. Multimedia applications increase the set of requirements in terms of throughput, end-to-end delay, delay jitter, synchronisation. These needs may not all be directly met by the networks; end system protocols enrich network services to provide the quality of service required by applications. Obviously, fixed end-system protocols are not able to support the wide range of application requirements on top of current networks without adding overhead in form of unnecessary functionality for multiple combinations of application requirements and networks.

The Aim of the RWANDA paradigm is to improve this situation by configuring end-system protocols to cater for the differing media within multimedia. Configuration serves to support a wide range of application requirements and to increase protocol performance by decreasing protocol complexity.

RWANDA is built upon a Java middleware application, closely modelled on the iBus framework, supporting event-driven applications on top of group communication protocols which implement a quality-of-service framework allowing programmers to compose protocol stacks for unreliable communication, reliable multicast, message encryption, and so forth. This provides a framework where applications need only pay for quality of services they need. RWANDA recognises the differing media characteristics and transport requirements within multimedia and provides run-time composable protocol stacks. This delays the necessity for defining protocols until the latest possible stage thus allowing for efficient protocol stacks. Channels allow for large scale decoupling of clients and servers – a necessary feature for large scale systems. The channels also allow heterogeneous receivers with differing capabilities to receive information.

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Computer-Based Visualization Technologies Applied to Participatory Design: Some Preliminary Results

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Abstract

In today's dynamic environment, project development organizations must continually struggle to remain cost efficient and effective. One of the most important and cost-driving phases of the overall product development process is product design. This paper briefly focuses on the need for more robust collaborative, virtual design environments, which depend on computer-based visualization technologies. A preliminary conclusion reached as the result of empirical testing at a U. S. Army vehicle development center is that the application of advanced visualization technologies has the potential to improve design team effectiveness and efficiency and decrease overall product cost and development time.

1. Introduction

The traditional product development process can be described as a sequential, linear process. Th activity has been characterized as a sequence of "throw it over the wall" processes where functi groups make contributions to a project sometimes independent of other elements [12]. As a res critical decisions that can significantly impact overall product design and develop frequently made without regard to the effect on and consequences to other functional element

But some process improvements are evolving. The need to shorten the development cycle [4], [9], [13], to achieve higher quality [1], [5], and to solicit direct customer feedback [10] h stimulated the need for changes to traditional product development methods. As a result, nu organizations, including the U. S. Army, are investigating the use of concurrent multi-fu teams coupled with emerging computer technologies to create more robust, collaborative vi design environments. However, this evolution, will require the integration of new strategies i design group interaction with new collaborative design tools if organizations are to become m effective, efficient, and competitive.

The purpose of this paper is to briefly describe how computer-based collaborative virtual des environments, tested and evaluated at the U. S. Army Tank-automotive Research, Develop Engineering Center located in Warren Michigan, can be used to improve interactive and conc product design team activities. Discussed are the product design evolution, collaborative vi design system testing and preliminary results, and some conclusions.

2. Product Design Evolution

In the past, products were developed on drawing boards using pencil and paper that represented two-dimensional (2-D) views of the product design. This process involved muc and error, serial reviews, and drawing revisions--a very time intensive process. Once desi complete, product manufacturers often created physical or functional prototypes so design te (and maybe their customers) could see, touch, and generally experience a product [10].

The onset of computer technology has had a positive impact on the product design process. T the process is initiated by developing 2-D and three-dimensional (3-D) solid models of alte designs on Computer Aided Design (CAD) stations--sometimes saving up to 70% of total i design time [3]. This technology has provided expanded capabilities for the develop timely revision of new product designs. However, while these enhanced the productivity of a single designer, their use is not very effective in a collaborative design or group review environment. To overcome this limitation, new tools and approaches are needed.

Emerging technologies which have the potential to significantly impact the product design process are virtual environment (VE) systems. By their nature, these systems are capable of stimulating the human senses of sight, sound, and touch. They allow a person to experience life-like domains and objects that appear to be real but only exist in a computer-based environment. In the eyes of a designer, immersion in such a near-realistic environment would provide visualization of the final product from various perspectives.

Using VE systems, a designer or a product design team could visualize a final product, assemblies, sub-assemblies, or components, in 3-D--a concept often called virtual prototyping (VP). Several different but related definitions exist. Some define VP as a computer-based simulation of systems and subsystems with a degree of functional realism comparable to a physical prototype that facilitates immersion and navigation [7]. Others define VP as a mechanism for visualization and testing of computer-aided design models on a computer before they are physically created [11], or others simply define VP as an electronic prototype [6].

3 Collaborative Virtual Design System Testing and Preliminary Results

3.1 Test Technologies and Test Design

Because of the potential of VE technology, U.S. Army Vetronics Technology Center and University of Central Florida researchers are testing and evaluating the use of computer-based visualization technologies for collaborative product design. Four technologies to be evaluated include: a Helmet Mounted Displays (HMD), Binocular Omni-Orientation Monitor (BOOM), Stereoscopic glasses, and traditional 3-D monoscopic CAD.

The research plan emulates the traditional design review process except that multi-functional design teams were used to solve design problems with the assistance of each of the four computer-based visualization technologies. Participants for the study were personnel from the U.S. Army Tank-automotive and Armaments Command (TACOM). The test population consisted of 12 male volunteers from six functional organizational elements. Four three-person randomly assigned design teams were made up of one designer and two non-designers of varying educational and discipline backgrounds. Each team was then randomly assigned to an experimental test sequence for each of the visualization technologies. Each test assessed different aspects of a new concept for a tow-mobile fuel tank that was mechanically connected to an armored tank to give it extended range of travel. Quantitative and qualitative measures were taken over a four-day test period. Quantitative data captured task completion times, error detection, and accuracy. Qualitative data were also collected on the capability of the visualization technologies to provide better quality solutions, improved design review processes, and overall reactions to the systems.

Before design evaluation and team testing began, it was hypothesized that one or more of the following computer-based visualization technologies would assist in collaborative design review activities by creating a mechanism for product visualization. This view was supported by others who believe that a VE environment would offer a common focus for multidisciplinary (managerial, technical, marketing, and manufacturing) groups to resolve design issues by sharpening their viewpoints in support of collaborative design evaluation [2], [8]. These visualization technologies, to one degree or another, offer the potential for true team interaction. Design teammates could simultaneously enter a virtual product design world, and jointly evaluate design issues, ideas, and parameters from their own experience, perspective, viewpoint, and functional responsibility. As a result, it is hypothesized that, people from various functional elements would thus become knowledgeable about all others activities and, therefore, would become an integral part of the total decision process.

In addition to participation and perception, it was believed that the use of VEs for product design could provide design flexibility by allowing the exploration of various options and the opportunity to generate and iterate "what if" exercises early in the design process where mistakes are inexpensive to correct. If so, significant cost savings could be achieved in system design and development because many of the problems would be identified and corrected prior to the actual physical product construction. In this way, VE technology would enable developers to refine designs before commitments are made, by bringing users into the design process much earlier, and allowing engineers to solve problems in a more collaborative, group setting.

The study was designed to provide insight into how commercial visual display systems impact the concept design review process. Answers to the following research questions were sought:

- Error Detection. Do design teams detect and identify more design problems and design errors when using 3-D visualization tools?
- Time to Detect. Do design teams detect and identify design problems and errors more quickly when using 3-D visualization tools?
- Time to Resolve. Do design teams resolve design problems more quickly when using 3-D visualization tools?
- Preferences: VE technology comparisons. What are preferences of usefulness, difficulty, practicality, stimulation for group interactivity, and development of group consensus when comparing the four display technologies?

3.2 Test Results and Discussion

Preliminary and general findings from the investigation of study questions, were as follows:

- Error Detection. There was a significant difference in the number of design errors detected across the four visualization technologies.
- Time to Detect. There was a significant difference in the average time to detect a design error across the four technologies.
- Time to Resolve. There were no significant differences among the four visual display technologies in the average time to resolve a detected design problem.
- Preferences: Technology comparisons. There were significant differences in individual preferences for usefulness, practicality, stimulation for group interactivity, and development of group consensus. However, there were no significant differences in the difficulty of using the four visual display systems.
- Additional Data. Descriptive statistical analysis revealed that design team participants are willing to use a traditional monoscopic monitor 34% longer than a HMD and 55% longer than either the BOOM or stereoscopic glasses and monitor systems.

Briefly discussed next are more specific findings with regard to error detection, time to detect, time to resolve, and preferences.

3.2.1. Error Detection

Study results indicate that statistically significant differences existed between the four visual dis technologies in the number of errors detected. Data showed that the number of design errors detected using the 3-D stereoscopic glasses and the monoscopic CRT monitor were significantly different from the number detected when using either the HMD or BOOM systems. Design teams were able to detect more errors when using either the stereoscopic glasses or the monoscopic monitor systems.

This finding can be attributed to the fact that both the stereoscopic glasses and monoscopic monitor configurations allowed design teams to simultaneously interact with the virtual model these two configurations, all participants were able to see the same model view concurrently. created a more natural, intuitive communication mechanism between team members. Obs indicated that test participants appeared to feel comfortable when using a single monitor since there was no need for team members to switch devices or places to view the model that can distract team activity. In contrast, inherent properties of the HMD and BO configurations prevented the entire design team to simultaneously interact and view the model under review. The systems which allowed only one person to control the model view found to restrict team dialogue and interaction and yielded lower performances in the numb errors detected.

3.2.2. Time to Detect

Study results indicated that differences existed between the four visual display technologies in average time to detect a design error. Data revealed that the average time to detect a design pr or to identify a design flaw when using the HMD were significantly different from the av detection times when design teams used any of the other three technologies. Design teams were to detect design errors faster when using the HMD. These results can be attributed to the effect immersion that the visual display device creates. By definition a HMD device is immersive, creating an environment where the user only experiences the virtual world and is not cogni the real world. In contrast, the BOOM and stereoscopic glasses systems are considered only immersive, thus creating an environment where the user sees and experiences a virtual world is cognizant of the real world. Users can remove the device and use the real world as a reference. The findings conclude that the design teams could detect design errors faster when using the HMD system. In addition, the findings reveal that the BOOM and stereoscopic glasses perform similarly and differed significantly from the performance when teams used the non-immersive, monoscopic CRT monitor.

One conclusion drawn from these findings is that users prefer the sense of total presence in the environment and if they can not have that level of immersion they prefer to revert back to their more familiar technology"--the monoscopic CRT monitor.

3.2.3 Time to Resolve

This study failed to find any significance between the four visual display technologies on the time it took the design teams to resolve a detected design problem. One possible reason is that after a problem was identified the design teams were observed to solve the problem without the assistance of the four visual display systems. Observations showed that test subjects reverted back to basic communication skills and practices and did not use the technology as the focus of their attention. Instead they continued discussions to resolve the problem without much emphasis on viewing the model.

3.2.4 Preference: Technology Comparisons

Usefulness--Analysis indicated that individual preference for usefulness of the technologies differed significantly between the four visual display technologies. Pairwise comparison tests reveal that when participants were asked to compare the four visual display technologies, they felt that the HMD and the monoscopic CRT monitor systems were the most useful technologies during the concept design review task. Users felt that the HMD and monoscopic CRT were analogously useful and that the BOOM and stereoscopic glasses were similar.

Difficulty--When individual team members were asked to compare how difficult the technology was to use when applied to the concept design review process, analysis concluded no significant differences between the four visual display technologies. All four of the evaluated technologies gave the users some difficulty in operating the system. However, users experienced problems when using all of the navigational devices: the mouse, the 3D pointer, and the BOOM functional buttons.

Practicality--Analysis results revealed significant differences in how practical the technology is for product design reviews. Pairwise comparison results indicate that practicality of using the HMD differed from all other evaluated technologies. Users believed that the HMD provided tha additional insight into the problem and could improve the overall product design. Data also sh that the monoscopic CRT monitor differs from both the BOOM and stereoscopic glasses sys Lastly, the BOOM and stereoscopic glasses yielded similar results and felt that these techn were the least practical.

Stimulation for group activity—Analysis indicate that individual preferences for how the tech assisted in stimulating group activity between the technologies differed significantly between four visual display technologies. Test results showed that when participants were asked to com how the four visual display systems assisted in stimulating group activity significant differ resulted. Design participants felt that the HMD and the monoscopic CRT monitor systems w more useful tools in assisting in stimulation of group activity.

Usefulness for developing group consensus—Design team participants were asked to compa useful they felt the technologies were in developing group consensus. Analysis indic significant differences exist between the four visual display technologies. Results from the pair comparison analysis show that the HMD differed from the other three visual display technology that the monoscopic CRT monitor differed from all the other technologies, and that the BOOM stereoscopic glasses were similar. Design teams felt that the monoscopic CRT monitor was most useful in helping design teams reach a consensus.

Additional Questions—Individual design participants were asked how many hours they would willing to use each of the four visual display technologies. Descriptive statistics conclude that average users are willing to use a traditional monoscopic monitor 34% longer than a HMD and 131 longer than either the BOOM or stereoscopic glasses systems. User comments support this find Some comments were: "it was familiar as using a PC", "easy to use", and "less tasking on a person."

4. Conclusions

Applications of virtual reality to the product design and development process has been intrig but empirical studies have been lacking. Several organizations are exploring the possibility designing products only in virtual environments, thus, eliminating the need for costly phy prototypes. Risk occurs when organizations must make decisions on which virtual environ tools are most appropriate. Design trade-offs must be made based on the state of the current technology and the demands on human perceptual and motor capabilities.

This research addresses how effective and efficient design reviews tasks are when using a collaborative, virtual product design environment based on a variety of visualization technologies. The purpose of this research was to provide some new insight into several VE design issues. The authors have developed a research strategy and methodology to measure the impact of visualization technologies on design cycle time, quality, and performance. Several research questions addressed are as follows. Do these tools actually assist the design team in accomplishing improved design reviews, thereby, yielding better quality solutions and products? Does this a virtual, collaborative environment improve communication and reduce the number of design iterations and changes? Is the overall productivity of the group enhanced? Which technologies are best?

Preliminary results of this study have lead the authors to conclude that the application of advanced virtual technologies to the product design process has the potential to significantly improve the efficiency and effectiveness of product design--the major driver of total product cost. Our belief is that, the testing and evaluation of computer-based visualization technologies in collaborative product design environments will provide important insights into the utilization of VEs for group product design tasks. Preliminary results indicate that one or more, visualization technologies has the potential to significantly improve collaborative product design reviews.

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VIDEO ON-DEMAND SYSTEM ARCHITECTURE

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Abstract

Recent technological advances made multimedia on-demand servers feasible. Two challenging tasks in such systems are satisfying the real-time requirement for continuous delivery of objects at specified bandwidths and efficiently servicing multiple clients simultaneously. Our project is aimed at prototype development of such a large scale server. This paper jointly addresses the issues of load balancing, responsiveness, streaming capacity and cost effectiveness of high-performance storage servers and delivery systems for data streaming applications such as video-on-demand or news-on-demand. We propose a relatively simple, flexible and robust video-server architecture.

1 Introduction

Advances in digital signal processing, data compression techniques, and high speed computer networks have made on-demand multimedia servers feasible. This project is aimed at the design and prototyping of a high performance large scale multimedia server that will be an integral part of future multimedia environment. The real-time requirement of continuous delivery of objeets at a constant bandwidth per object is a challenging technological issue. The continuous delivery at a constant bandwidth is required since once a video begins, it must be transmitted continuously for the duration of the movie. Another challenging design issue in multimedia systems is to service multiple clients simultaneously. Our goal is to build a scaleable and adaptable isochronous stream delivery system with distributed resource reservation/allocation on storage, network and client subsystems to provide preferential QoS services through an integrated network. In order to use our system for relatively short movies, minimum startup lateney plays an important role in our design.

Researchers have proposed various approaches for the storage and retrieval of multimedia data. [9] proposed a disk arm scheduling approach for multimedia data, and characterized the disk-level tradeoffs in a multimedia server. [8] proposed a model based on constrained block allocation, which is basically non-contiguous disk allocation in which the time taken to retrieve successive stream blocks does not exceed the playback duration of a stream bloek. Issues in designing media on-

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demand systems are discussed in [7], Various striping tradeoffs have been studied in [3, 11], [2] studied cost tradeoffs and scalibility issues in high performance media on-demand servers.

New protocols are under development by the networking community. RTP [10] is a real-time transport protocol that provides end-to-end delivery services to support applications transmit real-time data. RTCP is the control protocol that works in conjunction with RTP. The applicati level Real Time Streaming protocol, RTSP [5], aims to provide a robust protocol for streami multimedia over unicast and multicast, and to support interoperability between clients and serve from different vendors. Its draft specification is in the very early stages of submission to the IETF backed by heavy industry support. The Reservation Protocol (RSVP) [6] is a resource reserva protocol designed for integrated services networks, allows to reserve network bandwidth betwe hosts.

The rest of the paper is organized as follows. Section 2 describes the main characteristics of two subsystems of a video-on-demand system, the communication network and the storage syst Section 3 gives a detailed discussion of our design, including all the components. Section 4 summarizes on-demand delivery issues and gives a formal description of the model. Section 5 presents concluding remarks.

2 Characteristics of the Communication Networks and Storage Systems

The Internet Protocol Suite (IPS) has emerged as a dominant open architecture for traditio computer based data communications. Current efforts to define next generation protocols and services may well extend the applicability of IPS technology to broader roles in future inform infrastructures. In particular, efforts exist to research, develop and standardize an Integ Services Packet Switched Network (ISPSN) technology that evolves the current IPS to incl support for real-time and quality controlled network services. The increases in raw bandw available today, and promised by broadband networks of the near future, will continue to fuel the development of new applications that require Quality of Service (QoS) controlled network servic The traditional approaches to providing QoS control to applications have been found in the leas line, circuit switched and ISDN network environments. In such environments, QoS control realized by allocating the maximum resources required for any instance of communication „connection" that reserves these peak rate resources for the duration of the call. Such network services are highly appropriate for constant bit rate, peer-to-peer applications (e.g., voice teleph

Unfortunately, many of today's emerging applications require network services that are not efficiently supported by traditional circuit switched technology. Emerging applications that require integrated services are typically variable bit rate (e.g., MPEG streams) and adaptive to some variability in network performance. Multimedia applications can generally forego the complexity of TCP and use instead a simpler transport framework. Most playback algorithms can tolerate missing data much better than lengthy delays caused by retransmissions, and they do not require guaranteed in-sequence delivery. A number of protocols are under development by the networking community to enhance the Internet architecture and improve the support of applications like media-on-demand or interactive multimedia conferencing. We employed or currently employing RTP, RTCP, RSVP and RTSP in our prototype, and suggest modifications of these emerging protocols.

In most application storage systems, the semantics of requests are to „provide all the requested data as soon as possible" and a server is measured on the time until the last byte is received. In contrast, the intent of a request from a video server is to „begin providing data as soon as possible, then continue providing it at the predescribed rate". The primary measure of a video server's performance is the number of concurrent video streams that it can supply without glitches, subject to a sufficiently prompt response to user requests. The two primary resources of a video server are its storage capacity and its storage (communication) bandwidth. Unfortunately the two are embodied in disk drives and are thus coupled. So, in order to claim that a server can supply a given set of video streams based on the server's aggregate storage bandwidth, one must balance the communication load among all drives at all times, independently of viewing choices. Real time delivery can be achieved via clever scheduling but still often comes at a price, e.g. buffer space. Most published video server designs use a cycle based scheduling method in which each disk serves a set of I/O requests during a cycle and that data is played out to the display stations during the following cycle. This technique enables efficient disk scheduling by permitting scheduling of the requests in an order that minimizes seek times.

3 Video Server Design Issues

Our goal is to build a scaleable and adaptable isochronous stream delivery system with distributed resource reservation/allocation on storage, network and client subsystems to provide preferential QoS services through an integrated network.

Since end-to-end behavior is provided by a number of elements (storage system, network links, end hosts), we define and provide an integrated policy system such that when each element of system conform to the specified policy, they will collaborate to produce a delay-bounded serv with no buffer overflow and no packet queuing loss for conforming data streams. *Figure 1* shows prototype architecture of our system. Our architectural concerns are to minimize startup latency minimize buffer space needed at the servers, while maximizing the number of movie concurrent playback. We make the following assumptions about the construction of the server Video objects are displayed at a constant bit rate. 2) The server pool is homogeneous in term disk space, drive bandwidth, network bandwidth, and overall system bandwidth.

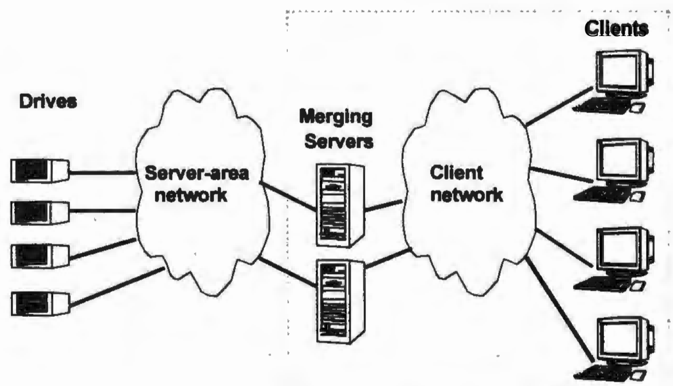

Figure 1.: Video On-Demand System Architecture

The our Video Server is compromised of a number of different components. They are the drive server area network (LAN), the merging servers, the client network (WAN), and the clients.

3.1 Drives

The drives are the storage component of the video server. All movie data is stored on the drives which are attached to the LAN. A data layout scheme in a multimedia server should supp maximal parallelism in the use of storage nodes and be scaleable in terms of number of cli concurrently accessing the same or different movie, and should allow simple scheduling sche that can ensure periodic retrieval and transmission of data from the storage nodes. In our lay scheme, the movies are striped across multiple disk drives to boost I/O, reduce start-up latency prevent hot spots. Drives do not communicate directly with the clients, but instead accept start/ movie commands from the merging server. In our model, each drive may be a NASD (Network Attached Secure Disk) device or a SAD (with server). Using NASD instead of a full-file workstation can significantly reduce the cost. Our architecture was designed with the NASD philosophy in mind [4].

We use variable-sized stripping units, because MPEG encoding has variable-sized frames, and constant frame rate. Each stripe unit corresponds to a fixed number of frames. The variability of the frames is bounded by the MPEG standard. When retrieving MPEG stream, the load on a node varies depending upon the granularity of retrieval. If a node is performing frame-by-frame retrieval, the load on a node retrieving an I frame is 6-8 times that on a node retrieving a B frame. Hence, it is necessary that certain nodes don't always fetch I frames and others fetch only B frames. The variability of load at the GOP (Group of Pictures) level may be much less than at frame level, and hence selecting appropriate data layout and retrieval unit is crucial.

We preprocess the video stream during data layout phase, parse the MPEG stream and add RTP-like datagram headers. The RTP-like headers contain only the necessary information required by the client, and not all the fields described by RTP RFC, which was originally designed for the loosely controlled video conferences. The headers provide framing for detection of dropped packets, timing information etc. After adding the header, we write an index file with list of stripe unit sizes.

3.2 Server and Client Area Network

The Server Area Network (LAN) is the network that the drives and the merging servers are attached to. It is assumed to be a high-bandwidth, low--latency network, since it needs to support many simultaneous video streams. OC3 ATM (155Mbps) or 100Mbps switched Ethernet is a reasonable minimum, and OC12 (622Mbps) is not unreasonable.

The Client Area Network (WAN) is the network between the merging server and video clients. Unlike the LAN, it may not have particularly high bandwidth to any one client, but there may be "extra" bandwidth available that can be used on a transient basis to some subset of the clients. The Internet and a cable TV distribution network are possible instances of WANs. We experimented the emerging new protocols in our prototype. RTSP is used in the connection setup phase, and RSVP is planned for reserving resources. During the video playback each packet, sent to the client, has an RTP-like header. It contains useful information at the client side for adjusting buffer size, and providing feedback to the merging server.

3.3 Merging Server

The merging server takes a unique place in our design approach. It has two functions: it merges the individual video streams from the drives into a single stream to the client, and it buffers prefetched data. Architecturally, the merging server is connected to both the LAN and the WAN. It accepts multiple streams per movie from the drives over the LAN (possibly buffering and reordering them) and then retransmits the stream to the video client over the WAN. It matches the two different architectures: the disk subsystem, which generates bursty traffic, and the network (WAN), which cannot handle bursty traffic efficiently. By moving the buffering per movie from the disks to the merging server, the required buffer space can be reduced.

The merging server also provides standards-based interface for initiating the connection setup by the client. We use RTSP (Real Time Streaming Protocol) between the client and the merging server for connection initiation, setup, and control purposes. Directory service is delegated to the merging server in the current prototype, but a separated Directory Server could be used. As a full-fledged augmented file server, it maintains the GOP/frame location mapping table of each striped MPEG title/file.

3.4 Clients

The client is the ultimate consumer of video data. It may be a PC or workstation with fair amount of RAM, CPU horsepower, and network bandwidth. It may also be a cable TV set-top box with very limited resources. In order to avoid excessive implementation constraints, we assume the resources on the client are fairly expensive.

We have built a demonstration client based on Microsoft's multimedia architecture, ActiveMovie (recently renamed DirectShow). The ActiveMovie architecture is defined by modular components called *filters* and connected by the *filter graph*. The filter graph manager provides a set of Component Object Model (COM) interfaces to allow communication between the filter graph and the application. Since the filter graph manager exposes a standard COM interface, the ActiveMovie filter graph can be accessed from a variety of applications. We can seamlessly integrate it with current implementations of the Informedia (Carnegie Mellon's Digital Library project) client. We also developed an ActiveX control component for video playback, which can easily used from other applications. The client initiates the connection via RTSP with the merging server, and [illegible] performance related information (jitter, dropped packets etc.) based on the RTP-like header attached to each datagram.

4 On-Demand Delivery

4.1 Schedule and Delivery

In our server design, we stripe video objects across all drives in the server pool, using a coarse stripe block size (approximately 64K-1MB). The stripe block size is chosen to improve the performance by reducing overhead from seek latency. Since movie access is typically sequential, the coarse striping should not cause unreasonable load-balancing problems. Stripe blocks in a video object are assigned to sequential drives in the server pool, with the initial drive chosen randomly.

A running movie can then be viewed as a series of periodic fetches, which begins at the drive with the first block of the movie, and proceeds through the drive pool sequentially. By combining the fetch series from all movies in the pool, a circular schedule can be constructed for a particular drive. This schedule lists the disk blocks to be fetched, in time order. Since all movies are striped across all drives in the same order, the schedule for any specific drive can be converted into the schedule for another drive by shifting forward or backward in time. Since the schedule for any drive can be calculated by any other drive, it is possible for decentralized scheduling decisions to be made by all the drives without central coordination.

Drives deliver the data streams to the merging server over the LAN. The size of the delay buffer at the merging server is an important design decision. It must be deep enough to hide drive/LAN jitter. Every stage should be at least double buffered. On the other hand, as the buffer size increases, the startup latency becomes larger. In the current prototype, the depth of each queue is two. The dynamic reorganization of the merging server's buffer space in order to reduce startup latency inspires further research.

4.2 Drive Architecture

The drive architecture consists of two elements, the scheduler and the transfer engine. *Figure 2* shows our model. The scheduler runs on-demand, when a request arrives from the merging server, or when jitters terminate etc. The transfer engine runs continuously to read data from disk and send to merging server. The transfer engine at each slot boundary queues disk I/O requests for each client in this slot, and queues network I/O requests for each client in previous slot. There are separa[te disk] and network I/O workers running to process queued requests.

Work requests (I/O requests) are submitted with the enque_req(object, start_addr, length, is_barri tag) function call, object is a unique identifier for the video object to be fetched. is_barrier boolean flag; if it is set, then the barrier flag is set on this request, which prevents subseq requests from being reordered to in front of this request, tag is a data structure which serv identify the request to the scheduler and network subsystem; it contains information about merging server, stream ID, and stream offset this request is for.

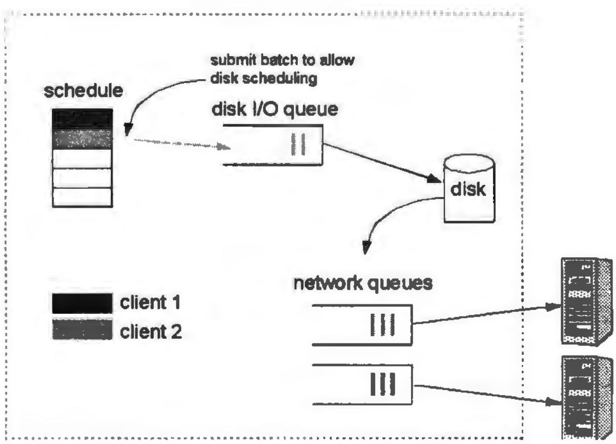

Figure 2: Drive Architecture

The disk scheduler removes work requests from the work request queue, possibly reorder[ing] (wh[ile] respecting barrier flags) them, matches them with free buffers from the free buffer queu[e, and] dispatches them in small groups to the disk. The disk may further reorder the requests, and t[hen] executes them. Completed work requests and their corresponding buffers are placed on the finis[hed] work queue.

Finished work is removed from the finished work queue. Patterns are matched against the[ir] contents. A pattern can be either an exact-match string or the wildcard '*'. This allows the net[work] to retrieve the first available buffer, the first available buffer for a specified merging serve[r or] specified stream, or a specific buffer for a specified merging server or stream. When the netw[ork is] finished with a buffer, it returns the buffer to the free buffer queue.

4.3 Formal Considerations of the Model

In this section we detail drives' scheduler and partially the data delivery to merging servers. We consider system with N drives, S merging servers, and M movies. Further, we use the following notations:

- $R_{outdisk}$ - maximum rate at which a drive delivers data over LAN
- R_{LAN} - LAN's throughput
- R_k^{ms} - maximum rate at which the merging server k can receive data

Thus, the maximum rate at which a drive can deliver data to a particular server k is

$$R_k = \min(R_{outdisk}, R_{LAN}, R_k^{ms})$$

Next we make the following assumptions:

1. Each drive has at least two output buffers (for prefetching). Thus, excepting the time when the first block of the movie is fetched, a drive will be always ready to send the next block during its scheduled slot. The duration of a scheduling slot is then,

$$T = \frac{B}{R_k}$$

where B represents the block size, and k denotes the merging server to which the data is sent.

2. The first block of each movie is stored on random drives. For convenience, without differing the mathematical description, we can assume that the first block of each movie is on the first drive.

The duration of a round associated to a movie transmitted through the merging server k is

$$T_{round,k} = N \times T_k = N \times \frac{B}{R_k}$$

The schedule duration, i.e., the time required to complete a round for each of the M movies, is

$$T_{Schedule} = N \times \sum_{l=1}^{M} \frac{B}{R_{ms(l)}}$$

where ms(l) represents the index of the merging server for movie l. Clearly, in order to maintain the throughput for movie l (over WAN) the following condition must hold

$$\frac{N \times B}{T_{schedule}} \geq r_l$$

where r_l represents the average bit rate at which movie l is delivered to the client(s). In words, if enough buffer space is available at the merging server the average rate at which the merging server should receive data must be no smaller than the rate at which the server should send data out (over WAN) to the client.

Further, we give the admission test and the start-up latency bound for a new request. A new req
j is admitted only if the new scheduling duration, i.e.,

$$T'_{schedule} = T_{schedule} + \frac{N \times B}{R_{ms(l)}}$$

does not violate Eq.(4) for any movie l (including the new one). Without giving a formal proof, w
conjecture that under the previous assumptions a new request (if admitted) can be inserted into
schedule as soon as possible. In other words, the data of the movie corresponding to the new requ
can be fetched in the next round. With this, the maximum latency experienced due the i
subsystem is at most the duration of the current round, i.e.,

$$D \leq T_{round,k}$$

where k denotes the merging server to which the data is transmitted during the current round.

4.4 Evaluation

We built a testbed to evaluate our functioning video on-demand infrastructure. The testbed
compromised of 8 disks, 2 merging servers, 4 'real' clients, and several 'dummy' clients. The serv
area network is a 155 Mbps ATM network, the client network is a switched Ethernet. The 'dum
clients are clients w/o MPEG decoding and rendering. These clients communicate with the mer
servers as the real clients, and log performance related data, but don't display the movie. Using
dummy clients, we can drive the system into saturation, and measure the number of maxim
concurrent connections. Currently we have a functioning system, which proves our design decisi
presented above.

5 Conclusion

We presented a media on-demand system based on a new architectural concept with the motiva
of reducing startup latency, buffering requirement while maximizing the number of conc
users. In our prototype successfully experimented the emerging, new protocols in order to prov
QoS guarantees over packet switched IP networks. Some important modification suggestions
these protocols are currently under way. The merging server, as a unique component, insp
further research in the field of active networks components, as we believe that its functions can
implemented in active routers.

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CAFE : CORBA-BASED FRAMEWORK FOR DISTRIBUTED MULTIMEDIA APPLICATIONS

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Abstract

The advances of networks and computing power result in that distributed multimedia applications are more widely used. But, distributed multimedia application is very difficult to develop and maintain because of heterogeneous platform, diverse of software language and network protocols. So, application developers need more time and effort. Especially, because most distributed multimedia applications are developed for special environment, interoperability between applications is very difficulty. To solve this problem, we have developed CORBA-based framework for distributed multimedia application called CAFE. CAFE consists of Collaboration Service, Enhanced Event Service, and Communication Service. CAFE helps multimedia developers to develop distributed multimedia applications easily. Also, because CAFE is based on CORBA environments, developer can be provided with various CORBA services and merits based on CORBA features.

1. Introduction

As information superhighway and advance of computing power, multimedia applications are more widely used, and it is needed more that distributed multimedia system like computer conferencing system, CSCW(Computer Supported Cooperative Working), distance learning system[3]. But, distributed multimedia application is very difficult to develop and maintain because of heterogeneous platform, diverse of software language and network protocols[9]. To solve this problem, framework is needed for the developments of distributed multimedia applications[2].

This paper designs CAFE framework for the developments of distributed multimedia applications. CAFE is based on CORBA(Common Object Request Broker Architecture) environment, and is designed using extension of COSS(Common Object Specification Service). CORBA is the standard of distributed application using object-oriented technology and provides the development methodology in heterogeneous and distributed environment[4, 5]. The designed framework provides object services for the development of distributed multimedia application. And, the development of framework can make interoperability with applications.

2. Relative works

2.1 Requirements in framework

In this section, we present a set of requirements for developments of multimedia applicati... order for the multimedia applications to develop reliably and efficiently, the followi... services are required : Collaboration Service, Communication Service, Enhanced Event Servic...

- Collaboration Service : Most distributed multimedia applications are used by multi-users. A... it is required that the abilities of the support of interoperability among users and the maint... information[1, 6, 9].
- Communication Service : CORBA 2.0 is not support the exchange of continuous multi... data(audio, animation and video). But, distributed multimedia applications - video conferenci... distance learning systems - require the transmission ability of audio/video data. A... communication service is required for the transmission ability of these continuous data[1, 7,8].
- Enhanced Event Service ; The processing ability of many events is required in multi... applications. But, COS event service transmits events to all consumer, so unne... communication is raised. Especially, it is very important in multimedia applications that i... events is raised in.

Figure 1 describes the layered features of framework for distributed multimedia application... top layer, there exist various multimedia applications which user the services provided by s... layer. The second layer consists of CORBA objects that implement the services required to s... multimedia applications. This layer consists of Collaboration Service, Communication Service,... Enhanced Event Service. These CORBA objects are used by multimedia applicati... development and run time such that they allow multimedia applications discover their sour... destination associations, create/join/destroy group, and exchange multimedia data. The distri... transparency is achieved by this layer using CORBA Object Request Broker, which al... communication within a domain as well as between domains by invoking methods defined i... CORBA objects. At the lowest layer, there exist various operating systems(such as Solaris, S... Windows 95/NT) and networking technologies(such as FDDI, ATM, Fast Ethernet, Token Ri...

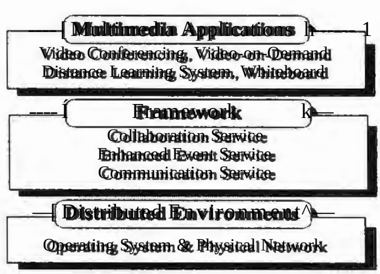

Figure 1. Distributed Multimedia Application Framework

3 Design of CAFE

3.1 Collaboration Service

Collaboration Service consists of Collaboration Manager, Group Manager, Application Manager, Event Daemon, Timing Event Manager. *Figure* 2 describes Collaboration Service. Collaboration Service consists of Collaboration Manager, Group Manager, Application Manager and Time Event Manager.

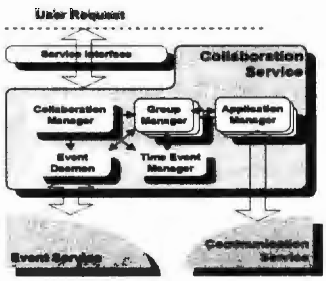

Figure 2. Collaboration Service

3.1.1 Collaboration Manager

Collaboration Manager authenticates user and creates Group Manager and Application Manager by request of group creation, and it maintains user/group information. Collaboration Manager provides interface for service administrator and the other users Service administrator is provided interface that can register user/group in service and update information. The other users are authenticated by (SeotID(Host IP address)). User information consists of ClientID, location information, grouplist that user is joining. Group information consists of GroupID, ClientID list, topic, and duration time values. Users are provided interface that has the operations of create/destroy group, join/leave group, retrieve user/group information, message sending. The types of message sending are unicast and multicast. Unicast is that send message to one user. Multicast is that send message to all members. If event is raised in Collaboration Manager, it sends event to Enhanced Event Service through Event daemon.

3.1.2 Group Manager

Group Manager is created by Collaboration Manager and maintains context of group state. Group context consists of participants' list, chairman information, token owner information and other information about group. If group context switching is raised, Group Manager send changed information to all participants through Event daemon. Group participants play a role of chairman, member and inspector. Chairman receives role when he takes part in group. The operations of destroy and token control can be controlled by chairman. Users can send message to partic when he has a token. In order to send messages, users request a token to chairman.

3.1.3 Other Components

Group members can accomplish cooperative work with various applications. Application Ma maintains information of application that is used in the group. Application Manager pro interface that has operation of register applications, update application information information is sent to Communication Service in order to create stream object between applications. Event daemon manages events from Collaboration Manager and Group Manage sends those to Enhanced Event Service. Time Event Manager maintains duration time infor of group. It can be used in time-dependent application such as video on demand, distance lea system.

3.2 Enhanced Event Service

In CORBA Event Service, events raised in supplier are sent to all consumers such as broadc type. This broadcasting type is expensive because some consumer may not need some events. total system efficiency is dropped. To solve this problem, we designed Enhanced Event Servi sends events to users who are interested in those. To accomplish these operations, Enhanced E Service uses filtering process.

3.2.1 Filtering Process

Enhanced Event Service provides interface that is for filtering process.

- Internal location of filtering – Enhanced Event Service creates filtering process between an consumer and an event channel. Because unnecessary transmission does not rise, network traffi decreased.
- Event Interception – When event is sent to event channel from consumer, service compares with event type registered by user. If comparison result is true, event is sent to event consumer.

3.2.2 The Composition for Filtering Process

- Registration : Registration object maintains event consumer and supplier that are registered service and filter list. And, it registers and maintains event types that are defined by users.
- Filter Factory : Filter Factory takes responsible for creation of filter by client's request. En

supplier can define destination filter, and event consumer can define notification filter.

• Filter Handler ; Filter Handler delivers event to consumer. Filter Handler registers event from supplier to Destination Filter, and decides that consumer registered in Notification Filter

• Destination Filter : Destination Filter describes group of event target. Description appears filter group that is applied to event consumer.

• Notification Filter ; Notification Filter describes event types or contents which are created, set by event consumer. And it defines filter set of event which consumer wants to receive. Expression consists of attribute name, operator and value.

3.3 Communication Service

Continuous media, such as audio and video, are essential part in distributed multimedia applications. But, current CORBA specification has not support stream transmission and control facility. So we design a stream based Communication Service, which support continuous media transmission between the users that are participated in distributed multimedia application.

3.3.1 Design of Communication Service

In this section, we describe Communication Service. Communication Service provides multicast transmission based on stream among clients. As *Figure* 3, Stream communication service is composed of communication manager, communication factory. Port object, Stream object, and connection object.

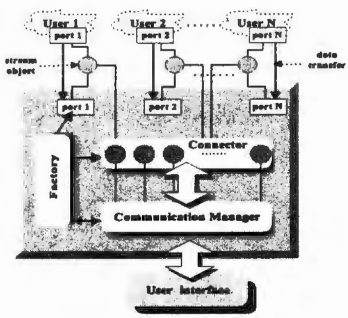

Figure 3. Design of Communication Service

In order to transmit continuous multimedia data, user must create Port object using Communication Factory. Communication Manager creates server side port object to receive stream data. Two ports, user's port and server side port, are bound by stream object. Stream object controls transmission of stream data between user port and server side port. If Collaboration service or each user request transmission of continuous media, Communication Manager creates two port object and Stream

object. One Port object is data supplier and the other Port object is data consumer. Co
object is created after Stream objects are created, and maintains reference of Stream object. A
performs the copy operation input stream to output stream. This Connector object is
multicasting transmission of steam data.

3.3.2 Port Object and Stream Object

Ports perform real media transfer. The basic control of ports is executed by stream obj
method related to stream transmission used by devices using transport interface. Port
interface is described with CORBA IDL, and provides control method of stream
behavior. Port control interface provides operations : Lock(), unlock(), Start(), Stop().
Transport interface provides operations : write_frame(), write_header(), read
read_header()

3.3.3 Communication Manager

Communication Manager process user's input, and performs work by transmission types.
Communication Service, it is required that user information(IP address, port number) is tran
When user connect to service newly, Communication Manager request the creation of server
user's Port and Stream object between Ports and Factory.

3.3.4 Connection Object

Connection object is user for multicast message sending. And so, It copy input stream to
stream. Connection object maintains information of a pair of input stream and output stream.
output stream is added to Connection object, it updates output stream list and copies input
for new output stream. *Figure* 4 describes Connection object

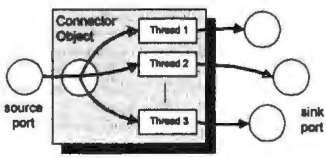

Figure 4. Connection Object

4. Design of Learning System using Framework

In this chapter, we implement video-lecturing system using designed framework. An envir
for implementing is following.

Media Stream Server : Pentium pro 200Mhz PC workstation, Microsoft Windows NT 4.0

Client: Windows 95 on Pentium 166Mhz PC

Networking Environments : TCP/IP protocol on 100base-T Ethernet

Real time Movie : software encoding/decoding module of MPEG-1

Developing Tools : Microsoft Visual C++ 5.0, Win32 SDK

ORB Software : IONA Orbix 2.2

A student executes a client application to connect media stream server. Then login dialog appears, and he/she inputs username and password. After login process, a group view appears to him/her. Then he/she selects a group that he takes interests in. When his/her participation succeeds, his/her participation is notified other students and lecturer in that group. Then, he/she can view lecturer's video stream and whiteboard. *Figure* 5 shows client application after participation.

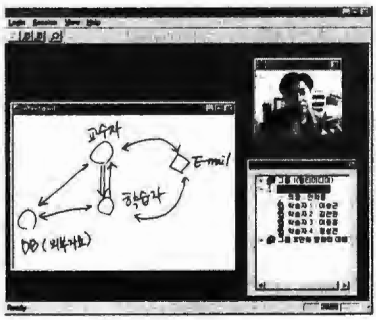

Figure 5. Client Application in Student Side

During video lecturing, lecturer can monitor participated students. Lecturer selects certain student to give token as the right of speech. The student who has that token speaks his/her opinion. After student's speech, lecturer owns that token for next right of speech. Also, a student requires token for his/her own right of speech. When lecturer draws some figures on whiteboard, these figures are shown to all participated students. *Figure* 6 shows client application in lecturer side.

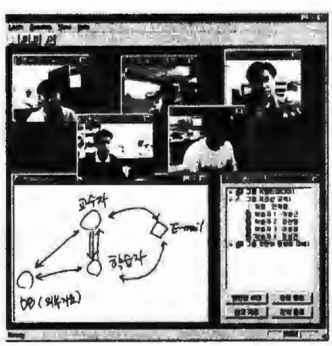

Figure 6. Client Application in Lecturer Side

Figure 6 shows the example that lecturer sent additional information to students with whit
These types of Session management facilities are enough to control the participated student
In this experimentation, we show that the designed framework can be used for applicati
require efficient group management and control, and it can support to handle user interacti
time environments.

5. Conclusions

In this paper we designed CAFE which it is CORBA based framework for distributed multi
applications. For this, we described requirements for supporting distribution of multi
applications and framework architectures that make of collaboration service, commi
service and enhanced event service. CAFE has several advantages over standard CORBA se
Using it, developing distributed multimedia applications are more easily and operating effici
distributed environments. The distribution transparency was achieved through the use of multi
service CORBA objects and ORB. It focused on developing various multimedia applications
require continuous media processing such as video conferencing, distance learning system. We
planing to develop interfaces between these services and others, and to implement more M
applications such as video on demand, digital library, etc.

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Panel

Tools: In Quest of Adequate Support

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TOOLS: IN QUEST OF ADEQUATE SUPPORT

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Introduction

In many ways, a new day has dawned on the world. This is no more evident than to open any business magazine and examine the prevalence of computer related advertisements. The world we are entering has been characterized as the information age. It is important that we seek to understand the nature of this emerging world and especially explore opportunities for effective application of information technology. Information technology enables enterprises to explore new ways of attaining and sustaining competitive advantage. All sizes of businesses and often entire industries are achieving higher levels of performance on all strategic fronts through the imaginative and skillful adoption of these technologies.

Cost effective tools are increasingly available to support organizations. Technologies once thought useful only in larger organizations are being successfully adapted for mid-size organizations. In fact, some of the most successful uses of technology in larger organizations have occurred in smaller business units. New tools and technologies with specific advantages for mid-sized organizations are increasingly prevalent, inexpensive, and can be effectively implemented in a timely fashion. Not every tool and technology, however, carries a "guarantee" of helpfulness. There are technologies that can help and technologies that can be harmful. It's sometimes not easy to tell the difference at first exposure. The challenge is to understand trends and the spectrum of support available to select technology that is a good "fit" with enterprise characteristics.

The purpose of this panel is to explore the nature of information technology in the workplace of the future that is quickly emerging from characteristics of our present work environment. Particular attention will be given to characteristics of the workplace of the future and the status, implications, and trends of information technology that will be an integral part of that future that is rapidly becoming commonplace in the present. Thus, we have titled this session "Tools: in quest of adequate support."

The Workplace of the Future

The twin forces of technology and globalization are rapidly transforming the way we work, indeed the very notion of work. It is likely that information technology will change the way we live and work as surely as has the advent of the telephone, jet plane and television. It is helpful if we think of tomorrow's fragmented geographically dispersed workplace as more a space, not just a place. There are a number of key drivers that give us a sense of this future workplace. These include: increased sensitivity to productivity of knowledge and service workers, an emphasis on quality, responsiveness, globalization, outsourcing, and partnering in an atmosphere of social and environmental responsibility.

In combination, these key workplace drivers give us a sense of a future that is, in total, a paradigm shift from the present workplace. There is an emerging new business environment revolving around a more open, competitive and dynamic marketplace. There is a new sense of enterprise that accordingly is open and networked resulting in an information-based organization. There is a new geopolitical order that is simultaneously open and volatile with many polarities. These are accompanied by new technology that is more open, user-responsive and network centric. The paradigm shift of the workplace is being accompanied by shifts in the application of information technology. The first shift is from office work to telework. The second shift is from personal to work-group computing. A third shift is from system islands to integrated systems. A final shift is from internal to inter-enterprise computing.

Shift From Office Work to Telework

Teleworking is the practice of working at home, or at a satellite location near the home, where employees use computer and telecommunications technology in lieu of physically traveling to a central workplace. The goals of teleworking is to move workplaces to the most convenient location for the worker. Telecommuting can occur in conjunction with a number of concepts and situations, including "hoteling," satellite office, team/group work, and home/virtual office. New computer and communication technologies allow the office to be wherever you are, no longer restricted by location, time, or physical structure.

Teleworking generally bundles in anybody who regularly works away from the corporate or client offices, including such alternative locations as a home office, a mobile office, even a hotel room. At one extreme, teleworkers include salespeople, agents, field engineers and consultants who often lack a corporate office entirely. At the other extreme, many are people who regularly or occasionally work after-hours, usually at home. In the middle are alternate location telecommuters; individuals who spend perhaps two to three days a week in corporate quarters and the balance of their time in a home office

Communications is the glue that holds the virtual office and telework together. Powerful networks capable of high speed transmission, and sophisticated telephone, and locator systems, make up the infrastructure. Each teleworker must have a computer; and by the end of the century, it is predicted that portable computers will replace desktop PCs in the corporate setting. Driving the switch to portables as primary computing devices is the migration to the virtual office concept of work. This trend is becoming easier to accept because the price gap between desktops and notebooks is narrowing.

The capabilities of a notebook are now so close to the desktop that many business people are using them as their primary computer. Because of the increased power and speed, today's notebooks can handle a full range of management, communications and financial software packages. Whether at home or on the road, users can perform any number of functions: analyze, calculate, and manipulate statistical data, prepare reports, spreadsheets, charts and diagrams, and create and print documents. In addition to basic management of numbers, portables have the memory to store information about long-term projects such as inventory lists, budget planning, tax records and investment planning/tracking. There is ample power to handle all the typical word-processing functions; the built-in keyboards operate exactly as those for desktops. A laptop loaded with the appropriate software can also act as a personal scheduler, calendar and note-taking device - a valuable tool for travelers or freelancers working from a variety of locations. Notebooks loaded with multimedia functions such as CD-ROM drives, video card for motion picture display, TV video adapter and stereo speakers are perfect for on-site demonstrations, for making presentations and illustrated lectures or for showing proposals or work-in-progress to clients.

Special software to support communication and coordination is also recommended for telewokers. for example, with the virtual-office software system Oxygen, developed by Boston-based Art Technology Group (ATG), a user can pull up any number of "rooms" at once on her screen and have real-time, interactive dialogue with anyone who happens to be there. Each user has his or her own "personal room"-formerly known as an "office"-which can be custom decorated with scanned-in wallpaper, baby pictures, or golf trophies. For informal chat sessions, there's the virtual cafeteria. But most of the day is spent with teammates in "project rooms" which are arranged on a map like so many subway stops, reflecting the company's organizational structure. Whether teammates are down the hall, at home, or in Singapore or Finland, they're all just a mouse-click away.

Shift From Personal to Work-Group Computing

Teams become a central focus of the workplace of the future. Information technology can make teams more effective and teams can help fulfill the promise of new information technology. Together, teams and new information technology can catalyze dramatic improvements in organizations as knowledge becomes the key strategic resource of postindustrial organizations. We are in the midst of a major shift is software emphasis toward supporting the work of groups. Group support systems or "groupware" as it often called is seeking to provide the same degree of comprehensive support for groups that personal computer software has provided for individuals. Team support can take a variety of forms. On one level, we can look at team support on individual, communication, and group dynamics levels.

- At the individual level, we have a variety of traditional support tools such as word processors, spreadsheets, and presentation support packages that are primarily designed to support individuals but which, on occasion, also support the needs of a team from an individual support perspective.

- At the communication level, we have a variety of tools to support interaction between individuals and groups, typically distributed in space and/or time. Products in this category include electronic mail, CollabraShare and Lotus Notes.
- At the group dynamics level, we are primarily concerned with concerted group effort, i.e., working closely together to achieve a result. Sessions need not be held at the same place or even the same time. Products in this dimension include GroupSystems, developed at the University of Arizona.

At all these levels, support platforms can include local area networks as well as the world wide web (WWW). On the next level of group support we have projects and organizational and inter-organizational forms of support.

- Team support in projects requires consideration of multiple sessions over time. Tracking team progress and maintaining an organizational memory that new as well as old members can access to begin to integrate information across sessions and between groups becomes an important concern.
- At the organizational level of work group support, attention shifts toward to workflow software that can help organizational teams sustain productive use of time even as new members join the teams. Special attention is given to organizational process support and improvement.
- At the inter-organizational level of work group support, attention shifts to communication and coordination between organizations. Group support for negotiation teams as well as contract implementation and integration across partnering organizations becomes a major concern.

Several extensions can be expected to occur along these dimensions.

- At the technology platform level, products increasingly are operative on the Internet and the world wide web (WWW).
- Artificial intelligence agents can be used at all levels of group support in a variety of creative and increasingly user-friendly fashions.
- Integration between now disjointed and embryonic software will become increasingly commonplace. No longer will organizations have to work to create links between islands in the archipelago of relevant information and associated software support.
- Extension to multiple media forms will become increasingly commonplace and cost effective. Videoconferencing that once cost over $100,000 and currently costs over $10,000 will be replace with videoconferencing on a chip costing less that $1,000 which will then disappear as a separate cost item as full motion video becomes just another data type on the computer's central processing chip.
- Further, the video will be better synchronized with the audio and will additionally better complement presentation and group discussion data. The ultimate key to success is integrated audio, video, and data.

Overall, this shift from personal computing to work group computing has been described by many, including Andy Grove (CEO of Intel) as the most significant shift in computing since the introduction of personal computers. The introduction of personal computers in organizations brought computers out of the basement and into offices to the extent that there are now more computers than people in most organizations. The ability to interconnect these computers and provide an element of support for work groups promises to have the same universal impact. Mid-size organizations may well lead the way in the innovative application of work group computing. As business becomes more global in scope and computers become more ubiquitous in the workplace, the need for collaboration -- and computer-based collaboration -- will surely continue to increase.

Shift From System Islands to Integrated Systems

Teams of professional knowledge workers draw upon the IT infrastructure for resources and coordination. Information technology has the capacity to spread information and intelligence throughout a system, so that people can be completely integrated even though they are far apart. Shared knowledge and databases become increasingly important as we focus on human assets and the development and support of intellectual capital. Various forms of team support including project tasking, tracking, performance management, and resource allocation take on importance as extensions of team activities. Interesting, we see less attention and focus on materials management programs -- they often add little in the way of large bottom line numbers compared to human resources and numerous packages are available and can be easily purchased from a variety of vendors and consultants. The key to the future is integrating information sources and provision of executive support.

The world wide web (WWW) has emerged over the past couple of years as a ubiquitous and pervasive technology that epitomizes this shift from system islands to integrated systems. Current organizational focus on WWW exists from two perspectives, (1) access to external information and internal integration of existing resources through an "Intranet" using Internet technology to construct private, corporate Webs and (2) linking organizations together and providing direct customer access. In the following section, we address Intranets.

Typically, Intranets are for the use by internal employees only and are shielded from unauthorized observation by firewall technology. Companies that have a corporate network can very rapidly introduce very large Intranet systems. In some more forward thinking organizations, Intranets are enabling significant organizational redesign efforts. Such Intranets are currently being used for a range of activities such as publishing internal reports, telephone address lists, marketing collateral, annual reports, providing access to corporate databases and simple groupware applications such as scheduling.

- Intranets are also gaining enormous popularity in many companies because most of the Intranet architecture already exists in the form of their corporate backbone network. So long as it is able to transport the Internet protocol stack, TCP/IP, then the existing frame relay, X.25, or even ATM networks are perfectly suitable. Indeed, smaller organizations without a private network of their own can use the public Internet, coupled with firewall technology, to form their own, highly cost-effective virtual private network. Many companies are looking at servers running either a version of Unix or Microsoft's Windows NT. In the future, massive Intranet servers (so-called 'thick' servers) may hold all corporate data and applications. Users, equipped with modest desktop Intranet clients (so-called 'thin' clients) would use the corporate network to download everything--including data, application 'applets' and even the operating system itself, as and when required.

Shift from Internal to Inter-Enterprise Computing

It is also increasingly important that organizations not look just internally at integrating technology but also look toward external integration i.e., linking effectively to other organizations. Technologies of "reaching out" include those we currently use widely e.g., FAX but also increasingly electronic document interchange (EDI) and point of sale customer contact. Electronic mail is replacing much of the routine paper based personal interaction within and between organizations. Inter-enterprise databases and applications that span organizations are becoming increasingly prevalent.

The shift from internal to inter-enterprise computing is epitomized by the emerging attention to electronic commerce (EC), the electronic exchange of business information. This evolving process includes the electronic connection of any person, application or computer to another in some mutually agreed structured or unstructured standard. EC is often commonly associated with the buying and selling of information, products, and services via computer networks today and in the future via any one of the myriad of networks that make up the Information Superhighway. Historically, EC builds on Electronic Data Interchange (EDI), i.e., the transmission, in a standard syntax of unambiguous information of business or strategic significance between computers of independent organizations.

Electronic commerce is considerably more than EDI or our current notions. Kalakota and Whinston (1996) define Electronic Commerce as a modern business methodology that addresses the needs of organizations, merchants, and consumers to cut costs while improving the quality of goods and services and increasing the speed of service delivery. EC applications include: supply chain management, video on demand, remote banking, procurement and purchasing, on-line marketing and advertising, and home shopping to name but a few. Electronic Commerce Phases include: Pre-contractual, Contractual, Ordering and Logistics, Settlement (invoicing/payment), and Post-processing. It is important that we look out to the future of electronic commerce combines with what we can do now as "cyberspace" becomes the future business environment.

Electronic commerce tools consist of a combination of hardware and software and, typically, a service provider with a value added network. Special hardware requirements are relatively few and focus around providing a PC or some form of connection, often through a modem, to a telecommunications provider. Specialized EDI (Electronic Data Interchange) software is readily available and increasingly easy to use. Standards are rapidly emerging as is the ability to transfer data between systems using competing standards. Many larger organizations specify which standard they expect their suppliers to use. An additional level of equipment is often provided by a service provider who may support a VAN (Value Added Network) at a competitive price to ensure rapid and reliable communication between sites engaging in electronic commerce. Such service providers are often a good source of information to sort out connectivity problems encountered as electronic commerce systems are being implemented and also often provide access to the World Wide Web and development and/or maintenance of Web home pages.

Tools for Collaborative Problem Solving: Group Support Systems

One of the key issues that will determine the success of the organization of the future is its ability to foster creative problem solving. The problems that the organization of the future is faced with, will be even more complex and difficult than today. An organization's success to survive and be prosperous will largely depend on its ability to mobilize the creative capacity of its workforce to tackle these problems.

Various methods, techniques, and technologies exist to support collaborative problem solving. One technology that will be highlighted below concerns Group Support Systems (GSS). A GSS can be defined as a system consisting of computer software, computer hardware, problem solving procedures (methods, techniques), and facilitation that support groups engaged in intellectual collaborative work. Their aim is to make collaborative problem solving meetings more productive and effective. GSS are not a "new" technology. Since the early prototypes in the late 1960s and early 1970s, a number of commercial GSS were developed and marketed in the 1980s, such as GroupSystems and VisionQuest. The 1990s showed a further increase in the number of commercial GSS. Nowadays, GSS are used to support a large variety of group activities, ranging from strategic decision making to more operational groups tasks, such as standard education activities or weekly staff meetings.

Since their inception, GSS have become a popular topic of research in a variety of disciplines. As a result, a substantial body of knowledge has emerged about the effects of GSS on group processes and outcomes. If we discriminate between field studies (studies involving real organizational groups) and lab studies (studies involving student subjects), we do not yet see conclusive evidence of the positive effects of GSS on group problem solving. Although field studies report mainly positive perceived and observed effects, lab study results are more varied. However, there is enough evidence to claim that GSS do have a distinct potential to provide effective support for collaborative problem solving, *if* they are skillfully employed.

Especially with respect to the, sometimes overwhelming, positive results from GSS field studies, the extent to which GSS have penetrated real organizations is somewhat disappointing. In an absolute sense there are a substantial number of electronic meetings held every day. Some sources claim that more than two million people world wide have participated in thousands of GSS-supported meetings. However, compared to the total number of creative problem solving meetings and workshops, the number of electronic meetings is fairly small. Many managers recognize the potential of technologies such as GSS, but refrain from implementing them in their own situation. This does not imply that there is no place for GSS in the organization of the future. On the contrary, the added value of GSS have been demonstrated in various studies and reports. So, what has to be done for GSS to get its place?

In order to prepare both the organization of the future itself and the GSS of the future for offering adequate (effective) collaborative problem solving support, a number of issues have to be addressed by GSS researchers and practitioners alike. These include support for distributed meetings, facilitation of GSS meetings, sensitivity for users' cultural background, and factors influencing adoption and diffusion processes. Each of these issues will be addressed below.

Distributed GSS

The rise of telework as a means of working together in a distributed environment, since the workplace itself, enabled by collaborative technologies, has the potential of shaping the organization of the future. In principle, the use of distributed GSS can enable people in different organizations and geographic locations to work together on a regular long term basis. This can result in making organizational and geographic boundaries less significant while enhancing networks of working relationships and enabling expertise and resources to be accessed from a larger pool. The ability to tap dispersed resources, mobilize coalitions depending upon the requirements of the task at hand or project being undertaken may be enhanced through the use of distributed GSS for conducting meetings, bulletin boards and shared workspaces and databases.' Such technologies have been known to bring about more regular contact with a mobile workforce, more flexibility to respond to client needs, dispersed project coordination.

The capabilities of the technology are far reaching and tool support is also available in the form of mobile phone, video conferencing, and asynchronous types of discussion lists to name a few, but organizations are slow to pick up on these technologies. One reason for this slow uptake is that in a distributed mode the technology itself becomes the space in which people have to interact. They thus have to learn how to use the technology on the one hand and then adapt it to their own ways of working. In organizations where this process of adaptation takes time, the uptake of the technology itself may not be seen to be worth the additional investment. Another reason for the slow uptake is that the technology itself is in the process of being developed and is not completely free of design problems leaving disgruntled users to thwart further uses of the technology. Perhaps the most significant factor determining the use of distributed GSS in organizations is the type of work process or task requiring the use of distributed group support. These are addressed further in the following sub-sections:

Communication

Work processes requiring simple communication between people in different geographic locations are quite easily supported through telephony, video, audio and computing (i.e. chat rooms) technologies. Being simple relatively easy to use, these technologies form a good fit with simple individual and group communication tasks requiring exchange of information, expertise and commitments between different people.

Coordination

Ensuring that sets of dispersed activities are carried out in synchrony, efficiently and effectively has to do with coordination. This can take place where a mobile workforce requires more then having a means to attune everyday business with employees on the road, and tracking their performance by asking them operational questions. At other times it may be necessary to mobilize the creative capacity of the workforce, arrange for necessary expertise to be available at required points in time. Such types of activities require more specialized support such as for accessing pools of expertise, and information in addition to the basic group communication tools for information exchange.

Decision making

Group processes in which decision making is predominant can also take place in a virtual workplace. The technologies available for distributed group decision making are numerous and varied ranging from simple text based "chat boxes" to highly sophisticated "telesuites" with seamless video, audio and computer connectivity. However, decision making processes are very much subject to cultural considerations (elaborated in more detail below), organizational characteristics, and business constraints and opportunities. In particular group decision making in a virtual workplace needs to capture the immediacy of face to face meetings so that the turn yielding cues, facial expressions and non-verbal communication may be exchanged - at least in part where necessary.

While simple tasks carried out in a distributed GSS environment or virtual workplace may not necessarily require specialized support beyond technical help or moderation facilities, it appears that the more specific the task, the greater the need for the specialized services of a facilitator or moderator who is conversant with the task being carried out and is able to help appropriate the technology to suit the work practices.

Facilitation

Facilitation is often identified as one of the main critical success factors for the successful application of GSS, both by participants in electronic meetings and by the facilitators themselves. Facilitation comprises of various activities to help a group move towards their desired outcome of a collaborative problem solving exercise. It can be considered a difficult activity, requiring skilled support. Good facilitators not only need to understand group dynamics. They also have to be sensitive to the political context of the group or of the organization that the group is part of. They have to have knowledge of various (group) problem solving techniques and methods. And last but not least, they have to be acquainted with the capabilities and limitations of GSS. In other words, a good GSS facilitator may be hard to find and even harder to train.

Nevertheless, given the increasing need for the organization of the future to engage in collaborative problem solving activities, the demand on facilitation skills will augment as well. This may be difficult:

- If the demand is high, resources may be scarce. Consequently, costs of employing facilitators may run high.
- If an organization decides to train facilitators themselves, it will take quite an investment in time before the candidates become proficient enough to become effective facilitators.
- Since good facilitators are in demand, organizations constantly risk loosing their experienced facilitators to competitors or consulting companies.
- Experienced facilitators that remain employed by their organization normally still move on to new internal jobs after a number of years.

In summary, collaborative problem solving facilitation skills will be in high demand in the organization of the future, requiring large investments in human capital by those companies.

Based on the above, one could argue that GSS need to be developed in such a way that their successful application becomes more facilitator independent. For some collaborative problem solving tasks this may be possible, see for example the work being done on GSS supported software inspections by Van Genuchten c.s. For other tasks using GSS without human facilitation support may just be impossible, because the combination of the process with which and the context in which the task is executed is just too complex, see for example the work being done by Eden and Ackermann on strategic decision making.

Culture influences in collaborative problem solving

The global nature of business is increasing. Organizations in the public and private sector collaborate or exist across national and cultural boundaries. Also people themselves become more mobile; employment outside one's country of origin is hardly an exception. This implies that the composition of teams working on complex organizational problems is diversifying. One can expect in the organizational problem solving team of the future to be working together with people from different cultural backgrounds. This presents us with new challenges for developing problem solving methods and tools. We have to be sensitive to various cultural values and characteristics if we are to successfully capitalize on the potential benefits of group supporting technologies and design better ways of employing them.

It has been shown that theories with respect to group behavior, organizational behavior and a variety of other disciplines are dependent on the culture of the groups or organizations studied. Not surprisingly given its origin, GSS research has predominantly addressed groups from a western cultural perspective, such as the USA and Europe. Up to 1988, almost all GSS research was carried out using American groups only. Even at this moment, comparatively little GSS research data is gathered on other cultures. Exceptions are some studies in the Asia-Pacific region, some studies in Mexico, and the first explorations in East Africa. Hence, as most conceptual and theoretical foundations regarding GSS technology have been based on traditional North American and Western European perceptions on groups of people working together, it is necessary to be cautious about concluding that "Western" GSS findings are transferable to other cultures.

An example to illustrate this concerns the anonymity feature of GSS. In research in a western cultural context, anonymity is often described as a beneficial characteristic as it helps people to overcome initial shyness and speak up. It enables a frank and honest exchange of viewpoints on certain matters. Experiences in South East Asia suggest that anonymity may actually be an undesired GSS characteristic, as open criticism is socially unacceptable. Experiences in East Africa are different yet in another way. Over there, anonymity is heralded as the best feature of GSS. People like exchanging comments and responding to other participants' contributions in a direct way. However, in normal meetings this is impossible because one is not expected to address the ideas of someone older or higher in hierarchical rank openly in a critical fashion. Whereas in most Western GSS meetings, people also orally discuss each other's idea directly after the anonymity has helped them overcome their initial shyness, in East Africa there remain two completely distinct meeting dynamics.

One of the most difficult issues in collecting data on the technology perception in other cultures, is that the cultural background of researcher can prevent him or her from interpreting the data in the right way. For example, since issuing open criticism to graduated people, such as researchers with a PhD, is socially not very well accepted in East Africa, it is difficult to do a critical assessment of the perception of GSS by the users. This may be even more difficult for local researchers that are not consciously aware of their own cultural frame of mind and its influence on their rendering and perception of field data.

The future: Understanding adoption and diffusion of GSS

In order to prepare the organization of the future for the successful implementation of collaborative problem solving support, we need more understanding of GSS adoption and diffusion processes. The issues of facilitation and cultural background are but two of a myriad of factors influence adoption and diffusion of group technologies. Adoption and diffusion processes of GSS seem to have an intrinsic complexity. The technology is introduced into an environment that is already complex by nature. This introduction subsequently has an impact on almost every aspect of this environment: the way people interact, the way the meeting process is structured, the way facilitators have to moderate, the shift in power positions or the possibility to use such positions, etc. In fact, the very nature of meetings is changing through the application of collaborative technologies. It has been said that meetings transform into a place where work is actually done instead of being planned to be done.

Diffusion of the technology is further challenged by the fact that groups appear to need time before they can fully experience and benefit from GSS. Given all the factors mentioned in the preceding paragraph it is not surprising that groups need time before they can feel comfortable in such a new meeting environment. In fact, research has shown that it takes at least three GSS meetings before a group has developed towards a situation where effective GSS application is consciously felt. No wonder GSS are a difficult concept to quickly implement in a large number of organizations!

Real organizational understanding of GSS adoption and diffusion processes is still very limited. Few in situ studies of GSS have been carried out. Most field studies involved one-time groups or a single group that is observed over the course of a number of meetings. It is seldom that researchers investigate the organization wide application of GSS for a significant period of time. Notable exceptions are studies at IBM, Boeing, the World Bank, and Nationale-Nederlanden Insurances (the Netherlands). Nevertheless, more efforts should be directed at getting a grasp on the factors and processes that make organizations and groups adopt GSS and that encourage their diffusion within a certain context.

In summary, GSS technology has a clear potential for supporting current and future organizations, but so far organizations have not been able to capitalize on it *en masse*. Future efforts by researchers and practitioners addressing the issue of creating effective support for group problem solving will have to come from two angles: an organizational and a technological angle. We have to build a very clear understanding what requirements the organization of the future will put on technological support for collaborative problem solving. At the same time, we have to explore the potential of new, networked computer technologies for supporting concerted problem solving efforts by groups that may be dispersed in time and place. If we can create fruitful synergy where these two angles come together, the effective application of GSS technology in the 21st century is within reach.

Tools for Knowledge Management: We Have to Overcome Some Pitfalls to Use the Enabling Functions

The main goal which knowledge management aims to pursue is to efficiently collect, store, process, distribute and apply knowledge - the most important resource of the

21st century. It is easily understandable that knowledge is more than the logical development of data and information considering that epistemology deals with knowledge for more than 3000 years whereas information specialists analyze data and information intensively for only about 30 years. Therefore the question should be asked whether tools from these data- and information-oriented approaches are actually useful for an integrative knowledge management.

Which areas does knowledge management include?

Knowledge management includes four areas. The *management of knowledge sources* tries to identify, collect and capture knowledge which is not yet available in employees' heads or company information systems. The main task of the *management of 'knowledge carriers"* is it to transfer this knowledge from the – human or computer based- sources into the company and to up-date it continuously. *The management of the knowledge supply* should guarantee that the knowledge necessary to solve problems is available for decision makers whenever needed. All three aspects of knowledge management mentioned so far are 'suppliers' for the *management of knowledge application*. Hereby the decision maker combines, interprets and assesses the knowledge offered and finally applies it.

Which starting-points do we have to manage knowledge?

There are four main starting-points for an effective knowledge management. The first starting-point is the *knowledge content*, which is evaluated according to its relevace for competitive advantage. *Corporate culture* should assure that the value of knowledge is acknowledged in the company and that there is the willingness to pass on and share knowledge. The main task of the *company organization* is it to establish structures and processes which support an effective knowledge management. Finally, *information and communication systems (ICT-Systems)* store, process and distribute information which is an indispensable 'raw material' for the creation of knowledge.

Which potentials are offered by tools for knowledge management?

Considering knowledge as linking new information and combining previous knowledge for a given problem, ICT-Systems can represent a sustainable potential for knowledge management. This ICT-systems can contain relevant information themselves or information about -technical of human – information sources. Consequently they are able to improve the supply of *'raw material"* for knowledge management. ICT-Systems facilitate structuring of individual knowledge as well as increasing the speed and the extent of knowledge transfer to others and facilitate enlarging the sphere of activity of the so far only locally existing knowledge.

A second essential potential of tools in particular from the area of data mining is the ability to *show interrelations among information*. Computer systems analyze thereby high volume data which is already stored in company databases, e.g. accounting, and try to find out interrelations among the data. Information about changing consumer behavior for example can be combined with certain marketing activities and training measures and generate a basis for new knowledge.

The third and certainly most exciting potential is the support of the 'intellectual coming together', the establishment of *'shared minds'*. The transfer of tacit knowledge will be supported thereby without needing to convert this knowledge into explicit knowledge. Douglas Engelbart was working not only on the invention of the computer mouse and graphical user interfaces in the mid sixties already but also on 'Augmenting the Human Intellect'. In the mid eighties Mark Stefik concentrated on 'Portable Ideas'. Today we have new tools to transfer values, norms, attitudes and estimations using multi-media communication systems.

Which pitfalls does a tool-oriented approach incorporate?

A first area in which pitfalls are likely to occur is the fact that tools exist for all areas of knowledge management but their respective *stage of development* - and their relevance for usage in business – *varies a lot.* Information systems as tools for managing 'knowledge carriers' are probably the furthest developed. Project reports are thereby stored in document management systems and consequently available for all employees. Afterwards the whole text is searchable for expressions as well as for project types, clients, employees etc. and available world-wide. Systems which transfer knowledge among employees and serve to generate new knowledge help to manage human 'knowledge carriers'. They support for example electronic forms of brainstorming as well as other creativity techniques and serve for computer based learning. Human resource information systems also belong to this category. In the area of knowledge source management tools like catalogues with manual data acquisition (directories) and search engines with automatic data acquisition (spiders) have gained on importance mainly because of the rapid development of the internet. These tools are used to find information sources in the internet based on search expressions. The area of information supply management is also already well developed. Examples are management information systems which consider personal information needs based on the usage of drill-down techniques or filter systems which also support individual information needs by working out personal interest profiles. Systems which support knowledge application on the other hand are not that well developed so far especially with regards to their usability in business. Examples are decision support systems which are often constrained to data and expert systems which only include explicit knowledge.

Based on these different development stages in the different areas of knowledge management there is a danger that a tool-oriented approach concentrates only on one area of knowledge management, most likely the 'knowledge carriers' and loses touch with other areas – usually the knowledge application which decides about the success of knowledge management at the end. According to a 'chain-philosophy' particularly the continuous support beginning with the knowledge sources and ending with knowledge application is especially important.

A second area with various pitfalls is the *incomplete reproduction of explicit and tacit knowledge*. Whereas information and especially data is relatively easy to present, store and transfer in ICT-Systems, this is not the case with knowledge. Explicit knowledge – information which has been combined and formalized – has to be inserted into the ICT-System via complex processes, e.g. neuronal networks or rule based systems. Very often explicit knowledge is only incompletely depicted or the 'combination' gets lost and knowledge is therefore reduced to information. Even a lot more difficult is the handling of tacit knowledge which exists only in peoples' heads in form of values, norms, attitudes and estimations and is therefore hardly to formalize. To use ICT-systems for tacit knowledge management, tacit knowledge has to be transferred into explicit knowledge first, afterwards it can be depicted in ICT-Systems, transferred to the end-user and internalized by him, i.e. explicit knowledge is converted into tacit knowledge again. This is a process which is not very likely to succeed. The danger of a tool-oriented approach therefore lies in neglecting tacit knowledge which plays nevertheless a very dominant role in successful companies and which represents a sustainable – not easy to imitate – competitive advantage.

A third area in which a tool-oriented approach encounters some problems is the *concentration on only one starting-point of knowledge management*. Either only the organizational area e.g. in form of modeling tools for business process reengineering or only the knowledge content area e.g. in form of electronic knowledge bases is supported. Whereas tools support cultural changes mostly in an indirect way there are however a lot of systems which are only technology concentrated and go past the actual impact mechanisms of knowledge management. Right there is a main pitfall of the tool-oriented approach: Either the demands on the knowledge content, company organization, and corporate culture will be neglected because of the technology concentration or only one of these three areas is supported. Following from that the usage of tools is confronted by too many opposite attempts and resistance of the other neglected areas to have a sustainable effect at all.

What significance does knowledge management have for tele-cooperation?

If tele-cooperation should be more than just transferring documents – via e-mail or distributed document management systems – it has to contribute to knowledge management. This means that tele-cooperation should not only serve information transfer but that it should support the transfer of explicit and even tacit knowledge. Experiences show that well working cooperations are characterized by more than an equal information level of the cooperation partners. The 'more' is shared knowledge. Neglecting this fact and reducing tele-cooperation to information distribution means also reducing cooperation quality.

What should we work on in the near future?

The proposed position paper tries to outline what we should work on intensively in the near future. This includes the consideration of all levels of knowledge management from the sources to the carriers and the supply to the knowledge application. It also means paying attention to explicit and tacit knowledge versus information and it comprises the implementation of measures in the area of knowledge content, company organization, corporate culture and ICT-Systems. Especially the last point shows what we don't really need: a continuing fight among technology and human centered approaches in knowledge management.

Highly Configurable Telecooperation Tools
Position Statement for the Panel
"Tools: the Quest for Adequate Support"

Max Mühlhäuser, University of Linz, Austria

Abstract

The position statement start by recalling a standard classification of telecooperation tools, then briefly comments on the state of the art. A quest is made for highly configurable and customizable tools as the only viable approach to computer-supporting productive telecooperation on a large scale. A highly configurable whiteboard is described as an example.

1. Introduction: Classification of Tools

In the remainder of this statement, a known classification of telecooperation tools will be used, based on three main categories cf. [1] (this classification forms a better basis for discussion than the well-known "four quadrants" spanned by the categories "same time / different time" and "same location/different location" [4]):

- **Communication:** tools which compensate for the lack of face-to-face collocation of all team members, such as audio/video conferencing and chat facilities.
- **Coordination:** tools or parts thereof which control operations and regulate the flow of action, such as floor passing [2], role or constraint resolution, application sharing (see below) etc.
- **Production:** the tools which support the very purpose of a telecooperation setup (such as a distributed electronic meeting); as is well known, such tools can be further divided into
  - **Cooperation-Unaware** tools, i.e. software which was built with a single user in mind, such as, e.g., CAD or office tools. Such software must be combined with an application sharing facility which replicates tool output onto the computer screens concerned and coordinates keyboard/mouse input (and possibly more) such as to mimik a single user with respect to the application.
  - **Cooperation-Aware** tools, i.e. software which was explicitly built for cooperative use; such tools range from rather general purpose (e.g., joint editing facilities or shared (software) whiteboards) to rather special purpose (e.g., cooperative CAD or cooperative simulation tools targetted for particular industry segments); many meeting support tools can be viewed as ranging between these two extremes (cf. tools which may, e.g., be built on a notion of "brainstorming" or a specific creativity technique).

2. State of the Art: Persistent Problems

Rather than providing an in-depth state of the art review (which a position paper has neither room nor purpose to do), the author would like to point to three problems with respect to the advancement of telecooperation; these problems seemed to persist over the last decade despite enormous research efforts:

1. (to be skipped for the panel) *the coexistence of two rather decoupled research domains:* "CSCW" and "workflow management". *CSCW* has developed strengths in domains best characterized as "rather synchronous work", "interdisciplinary research including the humanities", "small workgroups with creativity and little constraints"; *workflow management* on the other side has developed strengths best described as "rather synchronous work" "bridging computer science and business / management", "large communities with well-defined procedures and tightly controlled constraints". In order to increase the synergy between these two domains, the respective "communities" must be brought much closer together; only then, tools and methods can be successfully integrated. At least, the two communities have started to recognize the problem, efforts are under way. The tools problem will be a second step and will thus not be discussed further here.
2. (the main point for the panel) *insufficient promotion of specialized cooperation-aware tools:* according to the classification above, telecooperation today is often based either on cooperation-aware but rather generic tools or on domain or task specific but cooperation-unaware tools. A major reason is the development effort for cooperation-aware software (together with the high degree of expertise required in this domain; this expertise is hardly found among professional programmers and virtually lacking in the applying organizations).
3. (a side-remark for the panel) *lack of cooperation/management support for non-computer experts:* our experience with computer based classrooms and meeting rooms shows that non-computer experts - i.e. the potential users! - do not have the skills to instrument and control telecooperation tools the way they would like to. As the above classification indicates, different tools for communication, coordination, and production will often have to be used and controlled in a telecooperation setting; they have to be parametrized, multiplexed and controlled on different and often remote sites, and might even have to be handled differently for different subgroups. In other words, even the existence of adequate tools - required in item 2 above - is insufficient since the average user can not adequately combine and use them.

3. Core Statement: A Quest for Highly Configurable Tools

For more then eight years now, the research groups headed by the author have actively participated in the search for CSCW specific software engineering support. Languages, methods, protocols, and components have been developed with the intend to facilitate the construction of cooperation-aware tools. Yet up to now, the research results have not yet fostered tools which would have considerably penetrated revenue-generating or even mission-critical processes in telecooperating organizations. Obviously it takes considerable time and effort for any technology to be transferred from academia to software production to application (cf. object-oriented technology). One might argue that the technology developed might not be mature enough, but even well-renowned contributions such as the GroupKit development support [5] did not (yet) succeed in the field on a large scale.
In an attempt to improve and shorten the technology transfer cycle, our group has attempted a different approach lately: instead of aiming at "heavy-weight" software engineering support for the whole range of cooperation-aware applications, we are currently investigating "light-weight" composition support for more specialized segments of such tools. In a concrete project, we develop a *highly configurable electronic whiteboard* with the following rationale and features:

- Since we restrict ourselves to the narrow field of whiteboards, the tool and its components can be prebuilt to a stage where they can be configured by users with a certain degree of computer literacy.
- Based on the principle of decoration patterns, the "customizers" can pre-configure the whiteboard for a very specific use case; to cite just two examples, possible use cases may range from the planning of an oil pipeline where very domain-specific objects and constraints have to be considered, to the application of a creativity technique where ideas and arguments have to be treated in a well-defined manner. Since the whiteboard can be adopted to any such use case, its applicability remains very broad. At the same time, no software house has to be involved in customizing the general, highly configurable whiteboard for a particular use case.
- Object and relation types offered to the telecooperating whiteboard users may not only be configured as to their graphical attributes (shape, color etc.) and composition constraints; rather, many more "characteristics" can be reflected, such as whether or not (and which) role-based authorization support is associated with an object/relation type, whether or not respective objects are to be recorded (in a persistent "video" which can be reviewed in order to watch the "growth" of a whiteboard "drawing" as it happened during the meeting), how to reflect authorship (labeled, colored, etc.), whether or not to make the objects scrollable, etc.
- Not only traditional graphical objects can be configured this way, but also applet-like applications (such as videoconferencing output, wall clocks, animated characters, electronic meeting assistants, and many more).

The whiteboard example cited here is meant to demonstrate the quest made on the panel: a quest for highly configurable, cooperation-aware tools which can be readily delivered to organizations and configured there; the configuration support must be flexible enough to lead to tools which users will actually accept as sophisticated enough for serving their purpose in a satisfying manner (a requirement which, e.g., standard whiteboard software simply does not fulfil)

In addition to the above-mentioned central requirement, it has to be noted that problems 1 and 3 as cited in chapter 2 have to be reflected as well. As to problem 3, the Telecooperation Group at the University of Linz has developed a graphical group management software which provides drag-and-drop access to all configured telecooperation tools from a single consistent user interface, enabling all-in-one control of all tools and all workplaces. Floor plans and physical configurations (such as the setup of an electronic meeting room) can be incorporated and complemented with photographs of participating users and other person or role identifications in order to provide intuitive access to users and tools. For more details, cf. [3]

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Tools for Knowledge Management: We Have to Overcome Some Pitfalls to Use the Enabling Functions

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The main goal which knowledge management aims to pursue is to efficiently collect, store, process, distribute and apply knowledge - the most important resource of the 21st century. It is easily understandable that knowledge is more than the logical development of data and information considering that epistemology deals with knowledge for more than 3000 years whereas information specialists analyze data and information intensively for only about 30 years. Therefore the question should be asked whether tools from these data- and information-oriented approaches are actually useful for an integrative knowledge management.

Which areas does knowledge management include?

Knowledge management includes four areas. The *management of knowledge sources* tries to identify, collect and capture knowledge which is not yet available in employees' heads or company information systems. The main task of the *management of 'knowledge carriers'* is it to transfer this knowledge from the – human or computer based- sources into the company and to up-date it continuously. *The management of the knowledge supply* should guarantee that the knowledge necessary to solve problems is available for decision makers whenever needed. All three aspects of knowledge management mentioned so far are 'suppliers' for the *management of knowledges application*. Hereby the decision maker combines, interprets and assesses the knowledge offered and finally applies it.

Which starting-points do we have to manage knowledge?

There are four main starting-points for an effective knowledge management. The first starting-point is the *knowledge content*, which is evaluated according to its relevace for competitive advantage. *Corporate culture* should assure that the value of knowledge is acknowledged in the company and that there is the willingness to pass on and share knowledge. The main task of the *company organization* is it to establish structures and processes which support an effective knowledge management. Finally, *information and communication systems (ICT-Systems)* store, process and distribute information which is an indispensable 'raw material' for the creation of knowledge.

Which potentials are offered by tools for knowledge management?

Considering knowledge as linking new information and combining previous knowledge for a given problem, ICT-Systems can represent a sustainable potential for knowledge management. This ICT-systems can contain relevant information themselves or information about -technical of human – information sources. Consequently they are able to improve the supply of *"raw material"* for knowledge management. ICT-Systems facilitate structuring of individual knowledge as well as increasing the speed and the extent of knowledge transfer to others and facilitate enlarging the sphere of activity of the so far only locally existing knowledge.

A second essential potential of tools in particular from the area of data mining is the ability to *show interrelations among information*. Computer systems analyze thereby high volume data which is already stored in company databases, e.g. accounting, and try to find out interrelations among the data. Information about changing consumer behavior for example can be combined with certain marketing activities and training measures and generate a basis for new knowledge.

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Which pitfalls does a tool-oriented approach incorporate?

A first area in which pitfalls are likely to occur is the fact that tools exist for all areas of knowledge management but their respective *stage of development* - and their relevance for usage in business – *varies a lot*. Information systems as tools for managing 'knowledge carriers' are probably the furthest developed. Project reports are thereby stored in document management systems and consequently available for all employees. Afterwards the whole text is searchable for expressions as well as for project types, clients, employees etc. and available world-wide. Systems which transfer knowledge among employees and serve to generate new knowledge help to manage human "knowledge carriers". They support for example electronic forms of brainstorming as well as other creativity techniques and serve for computer based learning. Human resource information systems also belong to this category. In the area of knowledge source management tools like catalogues with manual data acquisition (directories) and search engines with automatic data acquisition (spiders) have gained on importance mainly because of the rapid development of the internet. These tools are used to find information sources in the internet based on search expressions. The area of information supply management is also already well developed. Examples are management information systems which consider personal information needs based on the usage of drill-down techniques or filter systems which also support individual information needs by working out personal interest profiles. Systems which support knowledge application on the other hand are not that well developed so far especially with regards to their usability in business. Examples are decision support systems which are often constrained to data and expert systems which only include explicit knowledge.

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What should we work on in the near future?

The proposed position paper tries to outline what we should work on intensively in the near future. This includes the consideration of all levels of knowledge management from the sources to the carriers and the supply to the knowledge application. It also means paying attention to explicit and tacit knowledge versus information and it comprises the implementation of measures in the area of knowledge content, company organization, corporate culture and ICT-Systems. Especially the last point shows what we don't really need: a continuing fight among technology and human centered approaches in knowledge management.

Tools for Collaborative Problem Solving: Group Support Systems

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One of the key issues that will determine the success of the organization of the future is its ability to foster creative problem solving. The problems that the organization of the future is faced with, will be even more complex and difficult than today. An organization's success to survive and be prosperous will largely depend on its ability to mobilize the creative capacity of its workforce to tackle these problems.

Various methods, techniques, and technologies exist to support collaborative problem solving. One technology that will be highlighted below concerns Group Support Systems (GSS). A GSS can be defined as a system consisting of computer software, computer hardware, problem solving procedures (methods, techniques), and facilitation that support groups engaged in intellectual collaborative work. Their aim is to make collaborative problem solving meetings more productive and effective. GSS are not a "new" technology. Since the early prototypes in the late 1960s and early 1970s, a number of commercial GSS were developed and marketed in the 1980s, such as GroupSystems and VisionQuest. The 1990s showed a further increase in the number of commercial GSS. Nowadays, GSS are used to support a large variety of group activities, ranging from strategic decision making to more operational groups tasks, such as standard education activities or weekly staff meetings.

Since their inception, GSS have become a popular topic of research in a variety of disciplines. As a result, a substantial body of knowledge has emerged about the effects of GSS on group processes and outcomes. If we discriminate between field studies (studies involving real organizational groups) and lab studies (studies involving student subjects), we do not yet see conclusive evidence of the positive effects of GSS on group problem solving. Although field studies report mainly positive perceived and observed effects, lab study results are more varied. However, there is enough evidence to claim that GSS do have a distinct potential to provide effective support for collaborative problem solving, *if* they are skillfully employed.

Especially with respect to the, sometimes overwhelming, positive results from GSS field studies, the extent to which GSS have penetrated real organizations is somewhat disappointing. In an absolute sense there are a substantial number of electronic meetings held every day. Some sources claim that more than two million people world wide have participated in thousands of GSS-supported meetings. However, compared to the total number of creative problem solving meetings and workshops, the number of electronic meetings is fairly small. Many managers recognize the potential of technologies such as GSS, but refrain from implementing them in their own situation. This does not imply that there is no place for GSS in the organization of the future. On the contrary, the added value of GSS have been demonstrated in various studies and reports. So, what has to be done for GSS to get its place?

In order to prepare both the organization of the future itself and the GSS of the future for offering adequate (effective) collaborative problem solving support, a number of issues have to be addressed by GSS researchers and practitioners alike. These include support for distributed meetings, facilitation of GSS meetings, sensitivity for users' cultural background, and factors influencing adoption and diffusion processes. Each of these issues will be addressed below.

Distributed GSS

The rise of telework as a means of working together in a distributed environment, since the workplace itself, enabled by collaborative technologies, has the potential of shaping the organization of the future. In principle, the use of distributed GSS can enable people in different organizations and geographic locations to work together on a regular long term basis. This can result in making organizational and geographic boundaries less significant while enhancing networks of working relationships and enabling expertise and resources to be accessed from a larger pool. The ability to tap dispersed resources, mobilize coalitions depending upon the requirements of the task at hand or project being undertaken may be enhanced through the use of distributed GSS for conducting meetings, bulletin boards and shared workspaces and databases. Such technologies have been known to bring about more regular contact with a mobile workforce, more flexibility to respond to client needs, dispersed project coordination.

The capabilities of the technology are far reaching and tool support is also available in the form of mobile phone, video conferencing, and asynchronous types of discussion lists to name a few, but organizations are slow to pick up on these technologies. One reason for this slow uptake is that in a distributed mode the technology itself becomes the space in which people have to interact . They thus have to learn how to use the technology on the one hand and then adapt it to their own ways of working. In organizations where this process of adaptation takes time, the uptake of the technology itself may not be seen to be worth the additional investment. Another reason for the slow uptake is that the technology itself is in the process of being developed and is not completely free of design problems leaving disgruntled users to thwart further uses of the technology. Perhaps the most significant factor determining the use of distributed GSS in organizations is the type of work process or task requiring the use of distributed group support. These are addressed further in the following sub-sections:

Communication

Work processes requiring simple communication between people in different geographic locations are quite easily supported through telephony, video, audio and computing (i.e. chat rooms) technologies. Being simple relatively easy to use, these technologies form a good fit with simple individual and group communication tasks requiring exchange of information, expertise and commitments between different people.

Coordination

Ensuring that sets of dispersed activities are carried out in synchrony, efficiently and effectively has to do with coordination. This can take place where a mobile workforce requires more then having a means to attune everyday business with employees on the road, and tracking their performance by asking them operational questions. At other times it may be necessary to mobilize the creative capacity of the workforce, arrange for necessary expertise to be available at required points in time. Such types of activities require more specialized support such as for accessing pools of expertise, and information in addition to the basic group communication tools for information exchange.

Decision making

Group processes in which decision making is predominant can also take place in a virtual workplace. The technologies available for distributed group decision making are numerous and varied ranging from simple text based "chat boxes" to highly sophisticated "telesuites" with seamless video, audio and computer connectivity. However, decision making processes are very much subject to cultural considerations (elaborated in more detail below), organizational characteristics, and business constraints and opportunities. In particular group decision making in a virtual workplace needs to capture the immediacy of face to face meetings so that the turn yielding cues, facial expressions and non-verbal communication may be exchanged - at least in part where necessary.

While simple tasks carried out in a distributed GSS environment or virtual workplace may not necessarily require specialized support beyond technical help or moderation facilities, it appears that the more specific the task, the greater the need for the specialized services of a facilitator or moderator who is conversant with the task being carried out and is able to help appropriate the technology to suit the work practices.

Facilitation

Facilitation is often identified as one of the main critical success factors for the successful application of GSS, both by participants in electronic meetings and by the facilitators themselves. Facilitation comprises of various activities to help a group move towards their desired outcome of a collaborative problem solving exercise. It can be considered a difficult activity, requiring skilled support. Good facilitators not only need to understand group dynamics. They also have to be sensitive to the political context of the group or of the organization that the group is part of. They have to have knowledge of various (group) problem solving techniques and methods. And last but not least, they have to be acquainted with the capabilities and limitations of GSS. In other words, a good GSS facilitator may be hard to find and even harder to train.

Nevertheless, given the increasing need for the organization of the future to engage in collaborative problem solving activities, the demand on facilitation skills will augment as well. This may be difficult;

- If the demand is high, resources may be scarce. Consequently, costs of employing facilitators may run high.
- If an organization decides to train facilitators themselves, it will take quite an investment in time before the candidates become proficient enough to become effective facilitators.
- Since good facilitators are in demand, organizations constantly risk loosing their experienced facilitators to competitors or consulting companies.
- Experienced facilitators that remain employed by their organization normally still move on to new internal jobs after a number of years.

In summary, collaborative problem solving facilitation skills will be in high demand in the organization of the future, requiring large investments in human capital by those companies.

Based on the above, one could argue that GSS need to be developed in such a way that their successful application becomes more facilitator independent. For some collaborative problem solving tasks this may be possible, see for example the work being done on GSS supported software inspections by Van Genuchten c.s. For other tasks using GSS without human facilitation support may just be impossible, because the combination of the process with which and the context in which the task is executed is just too complex, see for example the work being done by Eden and Ackermann on strategic decision making.

Culture influences in collaborative problem solving

The global nature of business is increasing. Organizations in the public and private sector collaborate or exist across national and cultural boundaries. Also people themselves become more mobile; employment outside one's country of origin is hardly an exception. This implies that the composition of teams working on complex organizational problems is diversifying. One can expect in the organizational problem solving team of the future to be working together with people from different cultural backgrounds. This presents us with new challenges for developing problem solving methods and tools. We have to be sensitive to various cultural values and characteristics if we are to successfully capitalize on the potential benefits of group supporting technologies and design better ways of employing them.

It has been shown that theories with respect to group behavior, organizational behavior and a variety of other disciplines are dependent on the culture of the groups or organizations studied. Not surprisingly given its origin, GSS research has predominantly addressed groups from a western cultural perspective, such as the USA and Europe. Up to 1988, almost all GSS research was carried out using American groups only. Even at this moment, comparatively little GSS research data is gathered on other cultures. Exceptions are some studies in the Asia-Pacific region, some studies in Mexico, and the first explorations in East Africa. Hence, as most conceptual and theoretical foundations regarding GSS technology have been based on traditional North American and Western European perceptions on groups of people working together, it is necessary to be cautious about concluding that "Western" GSS findings are transferable to other cultures.

An example to illustrate this concerns the anonymity feature of GSS. In research in a western cultural context, anonymity is often described as a beneficial characteristic as it helps people to overcome initial shyness and speak up. It enables a frank and honest exchange of viewpoints on certain matters. Experiences in South East Asia suggest that anonymity may actually be an undesired GSS characteristic, as open criticism is socially unacceptable. Experiences in East Africa are different yet in another way. Over there, anonymity is heralded as the best feature of GSS. People like exchanging comments and responding to other participants' contributions in a direct way. However, in normal meetings this is impossible because one is not expected to address the ideas of someone older or higher in hierarchical rank openly in a critical fashion. Whereas in most Western GSS meetings, people also orally discuss each other's idea directly after the anonymity has helped them overcome their initial shyness, in East Africa there remain two completely distinct meeting dynamics.

One of the most difficult issues in collecting data on the technology perception in other cultures, is that the cultural background of researcher can prevent him or her from interpreting the data in the right way. For example, since issuing open criticism to graduated people, such as researchers with a PhD, is socially not very well accepted in East Africa, it is difficult to do a critical assessment of the perception of GSS by the users. This may be even more difficult for local researchers that are not consciously aware of their own cultural frame of mind and its influence on their rendering and perception of field data.

The future: Understanding adoption and diffusion of GSS

In order to prepare the organization of the future for the successful implementation of collaborative problem solving support, we need more understanding of GSS adoption and diffusion processes. The issues of facilitation and cultural background are but two of a myriad of factors influence adoption and diffusion of group technologies. Adoption and diffusion processes of GSS seem to have an intrinsic complexity. The technology is introduced into an environment that is already complex by nature. This introduction subsequently has an impact on almost every aspect of this environment: the way people interact, the way the meeting process is structured, the way facilitators have to moderate, the shift in power positions or the possibility to use such positions, etc. In fact, the very nature of meetings is changing through the application of collaborative technologies. It has been said that meetings transform into a place where work is actually done instead of being planned to be done.

Diffusion of the technology is further challenged by the fact that groups appear to need time before they can fully experience and benefit from GSS. Given all the factors mentioned in the preceding paragraph it is not surprising that groups need time before they can feel comfortable in such a new meeting environment. In fact, research has shown that it takes at least three GSS meetings before a group has developed towards a situation where effective GSS application is consciously felt. No wonder GSS are a difficult concept to quickly implement in a large number of organizations!

Real organizational understanding of GSS adoption and diffusion processes is still very limited. Few in situ studies of GSS have been carried out. Most field studies involved one-time groups or a single group that is observed over the course of a number of meetings. It is seldom that researchers investigate the organization wide application of GSS for a significant period of time. Notable exceptions are studies at IBM, Boeing, the World Bank, and Nationale-Nederlanden Insurances (the Netherlands). Nevertheless, more efforts should be directed at getting a grasp on the factors and processes that make organizations and groups adopt GSS and that encourage their diffusion within a certain context.

In summary, GSS technology has a clear potential for supporting current and future organizations, but so far organizations have not been able to capitalize on it *en masse*. Future efforts by researchers and practitioners addressing the issue of creating effective support for group problem solving will have to come from two angles: an organizational and a technological angle. We have to build a very clear understanding what requirements the organization of the future will put on technological support for collaborative problem solving. At the same time, we have to explore the potential of new, networked computer technologies for supporting concerted problem solving efforts by groups that may be dispersed in time and place. If we can create fruitful synergy where these two angles come together, the effective application of GSS technology in the 21st century is within reach.

Note on using a Grounded Theory Case History method: Evolving an International Information System

Hans Lehmann

Abstract; *International Information Systems (IIS) have taken on increased importance as organisations develop and refine their global operations. A number of researchers have proposed frameworks for categorising and analysing these systems. Little research has been done to test these frameworks or to assess their relevance over time. This research note describes the evolution of an IIS as it follows its organisation's global business development. Using a grounded theory approach with a historical case analysis technique, the case supports the notion of an "information system migration" through various stages as the IIS adapts to the organisation's strategy changes. Lessons learned from this analysis and the method used in it are outlined.*

1. Introduction

Until recently, international information systems (IIS) technology as a field has been "..sometimes ignored altogether" (King & Sethi, 1993) and academic research is sparse (Cash, McFarlan & McKenney, 1992). However, little of even the current research is of direct help to systems build-up practitioners, who have come to regard IIS as difficult and risky. This is summarised by Huff (1991) and illustrated in a survey (KPMG, 1993) where only 8% of some 80 European firms had completed IIS development satisfactorily.

To address these development difficulties it seems appropriate to investigate the nature of an IIS's architecture. The importance of an appropriate architecture as a prerequisite for system building is well established (Olivé, 1985, Inmon, 1986, Zachmann, 1987, Earl, 1989, Matthews et al 1990,). This paper investigates the driving forces for an IIS architecture. Any such theory can then contribute to an IIS development framework, aimed at reducing their complexity and the risk inherent in building them.

To distinguish IIS from other distributed systems, in this paper IIS are defined as *distributed information systems which support similar business activities in highly diverse environments commonly found across country boundaries.*

Following a literature review and a brief discussion of the research method employed the main part of the paper is the description of the findings from the main case history. Finally, conclusions are drawn and an outline of the further research is presented.

2. Literature Review

As set out in more detail in literature review/s elsewhere (Hamelink ,1984, Sethi and Olson, 1993, Lehmann, 1996a), past research into international information systems is sporadic and spread over a wide array of topics.

Table 1 sets out a summary[1] illustration of the literature on IIS - darker shading reflects the more intensive coverage of the issues.

Table 1: Research Coverage of the International Information Systems Domain

Layer	Technology	Applications	Implementation & Social Issues	Management Issues	Governmental Issues
Scope and objectives					
Business processes model					
Information systems (design) model					
Technology model					

Only in the last few years have researchers begun to direct their attention onto the design and development of IIS. Some of this recent research focuses on the structure and architecture of IIS.

3. The Architecture of International Information Systems

Many researchers of IIS architectures use a framework for the classification of enterprises operating in more than one country which was developed by Bartlett and Ghoshal (1989). Butler Cox (1991) developed a model of IIS where there is a direct, one-to-one relationship between Bartlett and Ghoshal's global business strategies and these systems architectures. They distinguish between: *'Centralised'* systems; *'Replicated'*, i.e. copies of one central system; *'Autonomous'*, local systems; and *'Integrated'* systems, developed at local and central sites.

Other researchers propose similar relationships between information systems structure and global business strategy. Kosynski and Karimi (1993) describe (in the same sequence as above) 'centralised', 'inter-organisational', 'decentralised' and 'integrated' architectures. Sankar, Apte and Palvia (1993) define three global information architectures by the way their elements are linked. Ives and Jarvenpaa (1994), in a study of organisational fit and flexibility in IIS, which is also supported by previous case studies (Ives and Jarvenpaa, 1991, 1992, 1994) describe a framework of 'Global Information Technology Configuration' which also maps directly onto the Bartlett Ghoshal typology.

Table 2 (on the next page) contains a comparison of the four frameworks discussed.

1 After Lehmann (1997), from a framework suggested by Zachmaim (1987)

Bartlett & Ghoshal	Butler Cox	Kosynski & Karimi	Sankar et al	Ives & Jarvenpaa
Global	Centralised	Centralisation	Centralised	Headquarters-driven
Multinational	Autonomous	Decentralisation	Decentralised	Independent
International	Replicated	Inter-organisational	*(undefined)*	Intellectual Synergy
Transnational	Integrated	Integrated	Integrated	Integrated

Table 2: Comparison of architecture styles/configurations identified in the literature

It seems that just as the "*international*" business strategy is an intermediary stage, so are the corresponding global information technology configurations. If these replicated/inter-organisational/intellectually-synergised structures are regarded as embryonic 'integrated' architecture then just three generic architectures could be defined, namely

- Centralised;
- Decentralised (including autonomous and independent); and
- Integrated.

Whilst the centralised and decentralised structures are by now well understood and researched, the nature of the 'integrated' structure/arehitecture has rarely been an object of empirical study. Ives and Jarvenpaa (1994) describe it as "highly unstable - a dynamic balancing act between national responsiveness and global integration" and ask "what constitutes organisational fit under the paradoxical and highly dynamic transnational model?". The main research question in this study is similar:

What is the structure of IIS used in transnational firms and what are the forces that shape it?

4. Research methodology

The dearth of IIS research makes qualitative, theory building methods an appropriate choice. Such methods are well established in organisational research and are becoming accepted in information systems research too (Benbasat et al, 1987, Galliers et al, 1987, Yin, 1989, Lee, 1989, Orlikowski et al, 1991, Zinatelli et al 1994). In particular, Eisenhardt (1989) describes the process of building theory, focusing especially the central inductive process. Glaser and Strauss (1967) had set out to develop the Grounded Theory (GT) approach, where theory is left to 'emerge' from the data (in which it is 'grounded'). This empirical connection permits the development of testable, relevant and valid theory. Turner (1983) was one of the first to apply the GT approach to management studies. Since 1984, GT had been used in a number of business studies (Glaser, 1995). Orlikowski (1993, 1995) has pioneered GT in Information System (IS) Research. Yoong (1996) and Atkinson (1997) are recent studies.

In line with its sociological roots, GT methods in the IS field have been used mainly in social contexts, such as systems implementation and of group work. However, there is little reason why the basic principles of grounding theory in data need be restricted to social settings and individuals as the focus of research. This research project uses a GT method on the subject of systems architecture, using cases as the prime unit of analysis.

Glaser and Strauss (1970) and Glaser (1994) have set out criteria for the use of GT with cases - case histories in particular. They distinguish these from case studies, which in their definition are aimed at verifying pre-defined theory and are therefore *eo ipso* not GT. To use case histories in a GT approach Glaser (1994) prescribes a number of criteria:

- Case histories should be about one *social unit* only and must always be accompanied by a *theoretical commentary;*
- The research goal is to "get the *fullest possible* story *for its own sake*", as opposed to only selecting a specific focus for verification/generalisation purposes;
- Single cases need to rely on a - *substantive*[2] - theory to put them into "a more *general context of understanding*"
- Case history analysis may be used to *extend existing or generate new theory,* particularly this may be extended to several cases - using *theoretical sampling;*

The research methodology selected for the research project was thus characterised by the following:

1. Investigating the case history of an international firm of the 'transnational' type, which tried to create an IIS;
2. Using the linkage between information technology configuration and the Bartlett and Ghoshal strategic business model and Butler Cox's strategy migration model as the underlying *substantive theories;*
3. Applying constant analysis within the case to identify elements of *new* theory;

This constant analysis "*within*" the case is the salient difference between the traditional Grounded Theory approach where in general the primary unit of analysis is the *individual interview,* occasionally embedded in *discrete observations.* Coding of the information occurs 'between' the units. Using Grounded Theory in Case histories, on the other hand, defines the case (i.e. a collection of individual instances of data such as interviews, observations, documents, etc.) as the primary unit of data. Coding of data occurs then 'within' the elements (be they chronological, spatial, individual, relational, etc.) of the case and results in the generation of 'categories' and their 'properties' and their integration into a - suggested - new theory.

After each case an analysis is carried out as to which of the categories need more substantiation. The next case is then selected with a view to provide as much clarifying data on the categories as possible - i.e. lead the categories in question towards "*theoretical saturation*" (in Grounded Theory terminology). In this paper, only the first -m or "*foundation*" case - is described and the further stages in the study are described in terms of future research directions.

The constant analysis was carried out using the technique of "*ongoing theoretical commentary*" - as prescribed by Glaser and Strauss - during the collation and analysis of the case history. In order to demonstrate the stepwise, evolutionary nature of this technique, at points where one or other 'category' (theory element) manifests itself.

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Summaries of these theoretical commentaries are inserted in this format
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The following section gives a - considerably abridged - description of the case history.

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[2] Grounded theory terminology: a theory which only applies to a clearly defined research area

5. Australasian Food Producers' Co-op[3]

5.1. Business background

Prior to the mid 1970s Australasia exported the vast majority of its produce to the United Kingdom, who, under Commonwealth rules, used to accept it all. Once the UK had joined the European Union, however, they had to give free access to all other EU members, who flooded the UK with heavily subsidised product.

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Until then, the Co-op pursued, in Bartlett and Ghoshal terms, a "GLOBAL"
strategy
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Australasia had to develop new markets. A number of subsidiary offices was set up rapidly and agencies were nominated in the US and Canada.

The main emphasis in this period was to shift product quickly. The most effective way of achieving this was to staff these sales offices with capable individuals and "let them get on with it". As long as they managed to "move" their "quota", they had complete freedom of action.

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The Co-op then shifted to a "MULTINATIONAL" strategy company, with many
independent operators.
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This policy of local autonomy was successful. Within a decade the Co-op had built a presence in more than thirty countries and had managed, throughout, to secure a satisfactory return for the all their primary producers.

At the onset of the 90s, however, several developments were beginning to herald change for the Co-op:

- The uncontrolled growth in all subsidiaries had led to a proliferation of 'local fiefdoms' which were difficult to penetrate from head-office; the Co-op felt it had not enough control over the risks it may be exposed to by them;
- Competition in the food market had become increasingly global - with the emergence of global brands (such as Coca Cola, McDonalds, etc.); the Co-op needed to develop global brands themselves and had to have sufficient command (and control) to mount synchronised international marketing and logistics operations.

Reacting to these developments, the Co-op firstly developed a family of five principal global brands and rapidly began to build and/or acquire manufacturing capacity overseas. At the beginning of the 90s, the Co-op also began a concerted campaign to shift authority and control back to head-office. The arrival of a new Chief Executive Officer in 1992 instilled focus and urgency into this re-organisation process.

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The transition towards 'TRANSNATIONAL' is often correlated with 'maturing' in
international business(Butler Cox, 1991). The Co-op, is a natural candidate for
sharing its operations between the centre (growing and primary processing) and
value-adding processing locally because of perishable nature of the end-
products.
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Part of this new policy was a critical look at the role of information systems throughout the Co-op's operations.

[3] All names and most places have been changed. Any monetary values are in US $.

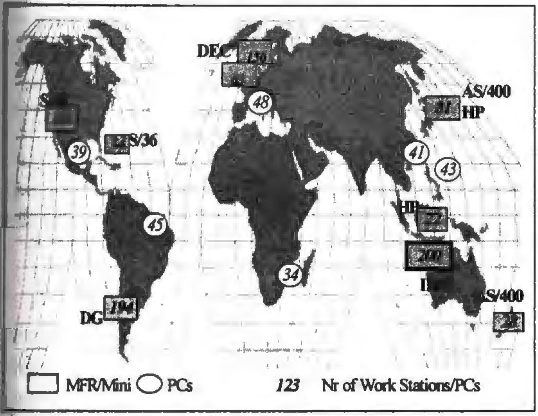

Figure 1. The Co-op's IS Configuration in 1992

5.2 The IS Landscape in 1992

During the 1970s, the Co-op had built up a sizeable IS department with a mainframe operation at the head-office, linking up with all the main subsidiary offices and ProdCos throughout the country. Foreign activities were few and hardly needed computer support.

The forced expansion drive in the 80's, however, lead to an increased need by local operations to be supported with information systems. By 1992 a number of regional offices had bought computers and software to suit their own, individual requirements. Figure 1. shows the distribution of computer equipment in 1992.

> This development gives empirical support of the connection postulated in the literature between IIS architecture systems and the firm's control strategy: central mainframe architectures go with the 'GLOBAL' phase and a shift to distributed configurations as the Co-op becomes a 'MULTINATIONAL'.

5.3 The Global Information Systems Project

Against this background of a proliferation of uncoordinated local systems on the one hand and a declared policy of more control from the Co-op's centre on the other, the Co-op's IS Department, then known (and further on referred to) as the Computer Centre, in April 1992 took the initiative to establish a "Framework for Information Systems" as the basis for globally common, technology, communications, data/information and application software standards, effective for all of the Co-op's 135 offices in 35 countries.

Taking such a far-reaching initiative for technology reasons, without anchoring it in business with a formal, executive level sponsor is bad professional practice

The business strategy was to introduce central control <u>while at the same time</u> maintaining the positive aspects of local control. The Computer Centre, on the other hand, was trying to replicate the control it has over the domestic operations all the way across the world-wide presence of the Co-op's operations - imposing the IS equivalent of the 'GLOBAL' strategy the Co-op had abandoned a decade ago.

This initiative was based on a 'Benchmarking Project' which had involved a visit by the computer manager to a number of subsidiary offices. From this an informal 'business model', i.e. a description of the business processes 'common' to all subsidiaries, was established and then developed in some further detail at head-office. This was intended to become the 'benchmark' against which future standardised information systems would be developed.

This is the first attempt to separate common and local systems functions - in this instance the conclusion was that "the business is basically the same everywhere" and that an "all-common" system would suffice. However, using a descriptive "benchmark model' to prove commonality across a widely diverse collection of offices of vastly differing sizes (from 6 to 500 employees) in different industries (retail, manufacturing, restaurants/hospitality) and in different functions, (i.e. marketing, sales, manufacturing, warehousing, distribution) is only possible at a very high degree of generality and abstraction. This, however, renders the 'model' useless for specifying information systems.

That such a highly general 'benchmark' was accepted as a basis for designing a common global system may stem from the Computer Centre's domestic skill/mind-set, commensurate with their strictly domestic experience: Previous analyses and the nearness of a well understood business environment keeps the risk of later in manageable proportions. In international environments, however, neither nearness nor intuitive understanding of business processes or practices apply.

Thereafter the 'Food Information Systems Teehnology' (FIST) project was created by the IS Department to implement the global systems outlined by the 'Framework' and defined by the 'benchmark'. The project's mission was:

"to both improve customer service and reduce the cost of doing business".

The first project strategy foresaw three stages:

1. Development of a 'prototype' system with a site which is reasonably representative for most of the Group's offices;
2. Implementation of the prototype in a small number of 'pilot' sites to adapt it for use as a global system.
3. Synchronised 'roll-out' of the 'global system' into all the regions and offices.

Estimated completion dates were late 1993, early 1995 and mid 1996 respectively.

These estimates were optimistic, especially where 18 months are allowed to install a system in 135 offices and familiarise 2,000 people with new systems.

This indicates that, again, a domestic skill/mind-set was applied: Domestic systems can sometimes be implemented using a cascade model to disseminate systems knowledge and experience. For reasons of geographical distance, as well as cultural, language, business philosophy and operational practice differences this cannot be assumed as readily for international implementations.

A statement was also made at this stage about the style of the project. In response to a query by the head of the Latin America office - who was worried that FIST would, from head-office and without consulting him, dictate a new, common/global system which would render his considerable investment in information systems obsolete - the Co-op's new CEO, gave the assurance that "... all regions will be involved and kept informed;... will be asked to nominate a representative who will be fully involved as a member of the project team." and further:" ... there is as yet no intention of requiring that each region adopt the same computer system".

> The FIST team's strategy and estimates, which rely on a "same computer system" and a strict regime of conformity with central standards for everybody - is the direct opposite of the CEO's intention.

In 1992 North America had started to embark on a review of its ageing IBM S/34. At the same time, Singapore was also looking to upgrade their fragmented PC-based installation to cope with the rapid growth in the region.

Both sites thus became candidates for the development of the prototype and also as pilot sites for further implementation. Both offices were asked to wait until the FIST team was dispatched to North America in September 1993.

5.4 North American Region Pilot

Having intended a system's upgrade in 1992 the North America Region was now, a year later, pushing very hard for progress. Bending to these pressures, the FIST team agreed to have selected technology, completed the prototype, tested and modified it as a pilot and to have gone live with the new system (which would at the same time be the first global system) by Jime 1994 - nine months hence.

> Unrealistic estimating because of the domestic skill/mind-set again: Acquiring a packaged systems solution within nine months is possible domestically. To select, acquire, modify, and test (in two 'pilot sites') information technology 35 countries - as well as implement a 'live' system North America - is not.

By the end of 1993, time pressure had also taken its toll on the style of the North America team: Instead of the participative approach envisaged by the Co-op's CEO at the beginning of 1993, FIST management was now actively encouraging the narrowest possible user participation in order to deliver a system by the June 1994 deadline. In reaction to this, at a Finance conference in November 1993, a number of the regional general managers strongly favoured broadly based involvement. The FIST manager complained: " The finance conference has significantly changed the rules...prior to this, we would progress with North America and keep the other regions informed when appropriate....now it is suddenly 'agreed' that every man and his dog would be involved all the time. The FIST timetable caimot absorb this extra involvement without bursting." An estimated timetable was presented, showing that the project would take three times as long and cost five times as much if participation by other the regional offices was to be allowed.

> Apart from being a political move to protect past estimating mistakes this is the domestic skill/mind-set again - assuming that the Computer Centre can get by on its experience, without input from the users.

As the North America pilot project progressed - by now past the June 1994 deadline - Business and Data Models were developed at head-office and in North America. They were compared with South East Asia (again) and Europe and in both cases a 90% to 95% match was experienced. However, as the regional manager Europe remarked: "These models are so general, they'd make IBM look like us." The European region subsequently opted out of the FIST programme.

> The inadequacy of the original 'benchmark' does not seem to have improved with other methods. This is in part a structural problem with data modelling and application modelling: these methods are not geared to describe/specify operations and processes , which is where many of the regional and industry differences are.

To counter the mounting resistance to the idea of one standard system for every subsidiary office, the FIST team began to look at what applications should be the same throughout the Group and which could be different for local subsidiaries. 'Core applications' (developed by the FIST team at head-office during 1994) were defined *"as those which organisations participating in FIST must implement in order to manage their business"* while 'Non-core' applications were defined by the following statement:

"The internal workings of processes by which some organisational outcomes are achieved are of no interest outside that organisation. When an organisation chooses to use an automated application to meet such needs, that application is considered to be non-core, no matter how essential it may be to the delivery of the outcome".

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This is the first time that 'non-core", i.e. local systems, are mentioned. It is
also the third approach for solving the problem. The definition is still
centrally derived, with no regional participation. Alas, the definitions are at
the same high level of generality and do not discriminate: Points (a) and (b) of
the 'core applications' fit anything any company could ever do and the
definition of 'non-core applications' (apart from making little sense
altogether) would also fit anything.
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Thereafter, the FIST team began with the implementation of the software in North America in September 1994 - and immediately encountered serious problems.

The manufacturing and distribution modules would not conform with the business processes they were selected to support. FIST responded with setting out a policy that *"where a choice existed between the change to business practice or change the system, the former would be the default choice"*. The North America regional manager, however, refused to change business practices which he pointed out were there in response to market and operational requirements. The software changes also turned out to require to be written by Datalogix because were affecting the very kernel of the application. The changes were estimated to cost $1,8m.

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The delayed consequences of

•  using the descriptive 'benchmark' model for requirements specification; and

•  the rushed selection processes.
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However, Oracle were negotiating with Datalogix about absorbing the Datalogix Distribution modules into their own ones. For the duration of these negotiations no work on the software was done.

By June 1995, the FIST project was a year late and $3.5m over budget. The FIST team suggested to carry out a sub-project of business-process-reengineering (BPR) in North America to implement there a prototype of the "Streamlined-Order-To-Delivery" (SOTD) process, which would then subsequently become the norm for all the Group's offices;

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This is the fourth try to solve the problem of common versus local systems
requirements. The technique is more process oriented, but, because of its
prescriptive nature, is politically charged.
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The BPR project with North America, however, never really got off the ground. The FIST team felt that they had already developed a set of standard business models, whilst North America maintained that these models were seriously outdated.

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This highlights a second, critical deficiency of descriptive modelling in an
international environment: reality often changes faster then the models can
document it, especially if they have to record it in the detail required for
creating information systems .. With anything but a small number of sites this
process can become infinite..
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Eventually the BPR project was abandoned and by the end of 1995 North America reached an agreement that its software could be altered - by ORACLE - so that it reflected their requirements.

5.5. Developments concerning FIST at the head office

The major difficulties with the FIST project, especially the missed deadlines, the significant costs (by 1995 approx. $ 8m) without any noticeable results and the refusal by a major region to accept the FIST system began to attract the attention of the CEO. In mid 1996 he commissioned Ernst & Young to evaluate the FIST projects. Their report was critical of FIST as being overly ambitious and not achievable within the time frame or the existing project set-up.

This proved to be a turning point: The CEO re-aligned the IT portfolio - and with it FIST- into the Finance department, whose General Manager had been an open critic of the project for a long time. The GM Finance has now re-positioned FIST: it's objective is now to first of all improve the effectiveness of the Co-op's operations - and secondly the acquisition of any technology to support this.

The FIST team have "re-staffed" the project accordingly.

6. Lessons Learned from the Case

The building blocks of a grounded theory are the 'categories' of facts distilled from the data and their "properties", i.e. the various aspects, manifestations, etc. of the category so described.

The main categories derived and lessons learned from the Co-op's case are summarised in the table below.

Categories	Lessons and *Commentary*
Migration through the global strategies: *The Co-op moved from a strongly centralised exporter to a de-central organisation with autonomous units. Subsequently the Co-op re-established some control from the centre and has probably now arrived at the level of the 'international" firm in Bartlett and Ghoshal's sense. The Co-op's IS mirrored the first two migrations. However, instead of aiming at an 'integrated', architecture, the Computer Centre attempted to extend the previous mainframe configuration;*	The Co-op's transitions bear out the linkage postulated in the literature on IIS architectures. It furthermore bears out the migration path presumed by Butler Cox (1991). There is thus an empirical foundation to these architecture theories.

Definition of Common and Local Systems: *The Computer Centre was unable to find a framework for the definition of what should be 'common" and 'local" processes and/or systems despite four attempts:* • *the informal approach of the 'benchmark" was too superficial,* • *the 'data/entity models" turned out inappropriate for distinguishing between processes;* • *Definition of 'core" and 'non-core" applications from the centre;* • *business process re-engineering proved unworkable as an analytical tool for this problem.*	The missing element in the establishment of the balance between local variation and global standard seems to be an empirical and pragmatic (as opposed to highly conceptualised) analysis of the <u>operational commonality</u> in businesses around the world and its subsequent use as a blue-print for the common parts of any international information systems. •
Domestic skill/mind-set in the design and implementation of information systems :: *The shortcomings of only knowing local information systems manifest themselves in a number of ways:* • *Wrongly estimating activities in foreign countries due to limited understanding of the local environments; Assuming that activities in the same business areas are the same across different countries;* • *Ignorance of important legislative and/or business culture restrictions in foreign countries;*	The main lesson is that what works locally, for a domestic system very often does not work for an IIS. Two conclusions follow: Support is given to the notion that domestic systems are different from IIS Local participation is a *sine qua non* for IIS development

Tendency for using political rather than factual arguments; *The key political actions were:* • *The Computer Centre initiated FIST to subjugate the regions to a higher level of central control but disguised this as a cost reduction exercise (threat of $80m expenditure if not checked; $21m benefit promised)* • *Inflated estimates of user involvement to avoid participation by regional management, i.e. possible dilution of the central control objective;* • *The BPR exercise, overtly designed to specify processes, but actually aimed at forcing North America to fit a preconceived process model.*	These - often blatantly - biased standpoints lost the Computer Centre creditability with regional management. This was further exacerbated by being seen as an attempt to justify by any means an IS structure out of step with the Co-op's business strategy, these actions. However, given the inherently highly political nature of the Co-op may be an underlying cause for this behaviour.
'Bad Practice' in an IS professional sense: *The instances were:* • *Major projects are initiated by the IS department without sponsorship by a business entity;* • *Time-frames during a Request For Proposal process which do not give sufficient time for suppliers or evaluators*	Given the higher level of uncertainty and complexity inherent in IIS, adhering to 'Good Practice' is important in IIS to eliminate at least this problem source.

7. Conclusion

Failure of the Computer Centre to recognise the pattern of the Co-op's strategy migration led them to attempt an IIS regime which was diametrically opposed to the business strategy. The Computer Centre's use of biased, political 'justifications' for their actions lost them further creditability.

These political problems were exacerbated by the Computer Centres inability to define the IIS's common and local modules with traditional methods, despite numerous tries. Inexperience with the business realities outside the domestic arena, coupled with inadequate adherence to professional 'good practice' furthered the eventual failure of the project.

The lessons learned are essentially four:

1. The linkage between systems architecture and global business strategy, as well as an expected route of migration between such strategies, should be taken as a guidance for setting up IIS projects;
2. Traditional methods for business and data modelling do not seem to be appropriate in the determination of what should be common/core systems and what should be local. It seems that commonality in the business operations could be a significant influence;
3. What works domestically often doe not for IIS. Local input seems to be essential for accurate understanding of requirements.
4. There is a strong political content inherent in the common/local decision, because it is seen as an issue of the degree of central control;

For the formulation of a theory - in terms of the Grounded Theory approach - it is now necessary to carry out more analysis with additional cases to obtain theoretical saturation in one or more categories. The next case should specifically allow the saturation of the ***Common/Local*** category and its - suggested - relationship with operational commonality among the local sites.

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Multidimensional Evaluation of Generic Aspects of Telematics Applications Quality: The MEGATAQ model

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Abstract

Usability testing of software has a respectable tradition, but with the arrival of networking technology and groupware, more and other issues than individual usability aspects become relevant. Assessment of the quality and effectiveness of communication, of co-operation effectiveness and of social or organisational implications is required for scientific research and for practical testing. Analysis of the literature reveals that separate traditions each tend to concentrate on limited aspects of this total picture.

In this paper a multidimensional system for the integrated assessment of individual, social and organisational usability criteria is presented. It is based on the experiences developed in a European Union project, called Methods and Guidelines for the Assessment of Telematics Applications Quality (MEGATAQ). It provides models, guidelines and concrete tools for an ongoing test-procedure during the various stages of the design of telematic applications.

1. Introduction

The combination of informatics and telecommunication technology has resulted in the development of what in Europe is called "telematics". This term is often loosely applied, both to certain infrastructures, to basic services and to applications based on this technology. Elsewhere the term tele-informatics is used. One function of this technology is to give users access to databases at a distance (tele-information). Another function is to provide new channels for information exchange and communication between people (tele-interaction). This second function is supported both by real-time systems (e.g. audio-/video conferencing) and off-line systems (e.g. computer-conferencing, workflow systems).

To support social interaction and teamwork, many (combinations of) tele-information and tele-interaction systems can be found. There aims can be threefold [21], i.e. to conquer space constraint, to conquer time constraints or to improve teamwork. Some are aimed at supporting ad hoc information exchange, others at supporting group meetings and presentations, or continuous teamwork and telework (for a taxonomy see e.g. [1]) The term multi-media is appropriate when these systems exchange more than simple data and text. When they support teamwork, the term 'groupware' is often used.

The fact that telematic applications are found in operational contexts points to the importance of evaluating their meaning and impacts at various 'levels'. Testing the extent to which their *human interface* is 'usable' for the individual user knows a well-developed methodology (see e.g. [31]). The limitations of these methods are also quite clear. They are largely restricted to aspects of individual human - computer interaction and they are mainly focused on individual task-oriented processes. Answering the question, whether a telematic application improves *access to information* and supports interpersonal *communicative behaviour* and *co-operation*, whether it contributes to group member's purposes and the *organisation's (or community's) objectives*, requires a different evaluation approach. Assessment of side effects, related to e.g. *quality of work*, *privacy* or *power(re)distribution* is also relevant. All these issues are covered in the so-called MEGATAQ methodology, developed in a European Union sponsored project, called Methods and Guidelines for the Assessment of Telematics Applications Quality (MEGATAQ).
The importance of systematic evaluation is evident in the policy of the European Union Research Program for Telematics Applications. Its objectives are to support the development of telematics for various sectors such as transport, education and training, research, health, rural areas. Analysis of previous programs showed that telematic applications are often hardly adopted because they were designed without sufficient regard to the needs of the user(organisation)s. The present research program requires user participation and systematic evaluation. Since consortia, who are developing telematic systems, do not always have the expertise to plan and perform systematic and valid evaluations, the Telematics Applications Program has initiated support projects, aiming at the development of relevant models and tools to assist the designers in this area. The MEGATAQ project is one of these support projects.

2. Four traditions

Analysis of the literature shows that the variety of relevant aspects has been covered in separate research traditions and communities: the fields of human-computer-interaction, communication theory, group dynamics and organisational effectiveness [1,2] However an integrated approach has been very rare.

2.1. Human-Computer-Interaction.

In the HCI community processes of cognitive functioning, mental models and cognitive workload have been studied, a.o. with the purpose of developing usable interfaces. Theories of cognitive psychology are relevant. Central is the question to which extent the interface facilitates the individual users' action. A powerful perspective is the one derived from Action Theory, including the concept of action facilitation [3, 14]. The starting point of this approach is the assumption that work is a goal directed activity. This activity proceeds on the basis of previously developed cognitive plans. Computers and other media are often the tools through which the plan is transformed into a result. 'Action facilitation' is the degree to which this (technical) support helps the development and the execution of the plans. The regulation of these plans can be skill-, rule- or knowledge based. Action theory states that people tend to maximise 'action efficiency', reflected in the mental effort that is required by a task. The theory has led to the formulation of several task and equipment design principles, e.g. related to feedback, action planning, efficiency improvement and mental load decrease. These same issues are then the basis for evaluation criteria. They are to some extent included in traditional usability testing of new systems with prototypes in a laboratory setting, i.e. early in the design cycle.

2.2. Communication theory: Mediated communication

In many situations, communication with others is vital and frequent. Distributed work requires support by telematic applications. In those cases human computer interaction is not only serving individual task performance but also interpersonal interaction. Central is the question, to which extent the use of media hinders or supports people's interaction and information exchange. Issues of non-verbal communication and context awareness (e.g. [10]) are important. Analysis of media choice and use, of conversational structure (e.g. interruptions, glances, etc.; see [32]) and of conversation content and conversation control (see e.g. [24]) can be found in this tradition. Research in this tradition shows that message systems increase connectivity and interaction. However, mediation of communication, even videoconferencing, implies less (non-verbal) information and signals for the participants, and thus less cues for regulating the social interaction. These findings are basic to media match theories such as '*Social presence theory*' [29] and '*Information Richness theory*' [9]. They explain why efficiency and effectiveness of mediated communication are optimal when the richness of the medium fits (within certain margins [22]) the communication richness that is required by the task. The more ambiguous [33], uncertain [12], or unanalysable [27] the task, the richer the medium has to be. Performing a complex task (e.g. negotiating) through a simple medium (e.g. email) is ineffective. Performing a simple task (e.g. sending a simple message) through a rich medium (e.g. video conferencing) is inefficient. This also explains why video conferencing often provides hardly any added value except some "situational awareness" (which nevertheless in some cases is quite an asset).

2.3. Group interaction analysis

Communication and co-operation is more often a matter of loosely coupled interaction and information exchange than of close teamwork. Nevertheless it appears, that also in such a situation the social context guides individual action and interaction [16]. New systems have to fit into this context and the adoption of systems may be partly determined by the social pressure of colleagues [4]. The *Social Influence theory* [11] gives a theoretical framework for this finding. This theory is related to general group dynamic models and *theories of team effectiveness* which provide more specific tools for the analysis of interaction processes in geographically distributed teams. For a general model of relevant processes and factors determining team effectiveness, the models by Sundstrom, DeMeuse & Futrell [30] and McGrath [19], and McGrath and Hollingshead [22] are quite helpful. Sundstorm c.s. elaborate the fact that team effectiveness is particularly determined by the organisational context and boundary-spanning processes.

In McGrath's "Time, Interaction and Performance theory' [20, 22] the dynamic group activities, and the role of group technology are modelled in terms of four modes: preparation, problem solving, conflict resolution and execution. Groups mature by passing through various stages and learning phases, which change the characteristics of the group but also of the technology used (see 'adaptive structuration theory', below). Finally, a group is considered to have three functions, to which technology also contributes: the production function, the member support function and the group well being function (= three outcome criteria).

Recently, *Activity Theory* has become popular for interpreting social behaviour-with-artefacts and for deriving design requirements for CSCW applications (e.g. [25, 18, 7]). This is partly due to the fact that it draws the attention to the, historically determined, social setting of new technology, with its rules and culture. In Activity Theory human beings are viewed as actors with motives, being part of and influenced by communities with a rich context. The context does not simply consist of a set of objective characteristics. A context is defined by the subject, and its characteristics are therefore 'in the eye of the beholder'. Here we recognise the structurationist perspective (see below).

For design and evaluation of telematic systems these theories point to team cohesion as criterion for the usability of group work oriented systems; to an analysis of the group structure and culture in which new systems have to fit, and to the various stages groups can pass through. It is clear that assessment as to these criteria requires analysis of socio-technical systems in operational use.

2.4 Organisational power and control

Besides the above mentioned group dynamic notions, research has shown that new technical systems can have (side) effects on community processes, the quality of work, distribution of power and organisational effectiveness. Any change in organisational structures or technology, particularly information and communication technology, challenges also power relationships, and is therefore a political process (e.g. [5,6]). Organisational change theories stress the fact that the more a new situation deviates from the existing one, the more energy has to be invested in the change program. So the usefulness and success of a tele-informatic system not only depends on the characteristics of the system and its direct context (users, tasks), but also on the way it is introduced in the organisation.

2.5 Meta-perspectives: fit or adaptation

In the above mentioned research studies and theories two different perspectives can be discovered, i.e. first the idea of fit, and second the idea of change and adaptation. They are related to two major trends in social theories, i.e. an objectivist and a subjectivist perspective [8]. In the first tradition the focus is on the way the objective characteristics of institutions and conditions shape human behaviour and social relations. In the second tradition social reality is viewed as a result of human experience, creation and interpretation. Theories of fit (Contingency theories) are of the first second type. Basic principle of these theories is that the (objective) characteristics of the social structure, of the technology and of human actors have to match, in order for organisations (or users) to be effective.

The principle of fit is fundamental to many design approaches, particularly in the area of HCI and CSCW. Media richness notions (see above) represent the contingency perspective in optima forma. It may be odd to challenge the idea that a new tool must fit the users and their tasks. There are however two types of criticism. First, although the concept of "match" or "fit" is intuitively quite clear, it is very difficult to measure it concretely. Secondly and more important, the contingency perspective is quite static in that it does hardly take into account dynamic processes of adaptation to and (re-)interpretation of tools and context by human agents.

Experience shows that adaptation processes take place when a new system does not fit the users and context completely. The more a new system deviates from this match the more intensive and of longer duration this adaptation process has to be [26].

Giddens [13], has developed a theory - the Theory of Structuration - which claims to integrate both the subjectivist and objectivist perspectives. According to this view, social reality is constituted by both subjective human actors and by institutional properties. Human actions are enabled and constrained by structural properties of social systems, but these structures consist of the residues of previous human action and processes of giving meaning to them. Or, the other way around, structures are created by human interpretation and action, and then serve to shape future human action. The implication of this notion is that social system effectiveness is not only dependent on the match between the context (task, tool, user etc.), but also by the way the task and the tool are viewed, re-interpreted and re-defined by the users.

Poole & DeSanctis [28], Hiltz e.a. [15] have applied this structuration perspective in their Adaptive Structuration Theory, in order to explain the way in which the actual use of certain groupware systems differs from the intended use. In co-operative teams it appears therefore often necessary, to go through a process of developing common understanding and shared knowledge ('common ground'), to reduce contradictions and ambiguities in media use and other behaviour (see also McGrath's four stages model, [22]).

For a comprehensive design oriented evaluation of tele-informatic systems a multi-level approach is required, which is based on theories such as presented. On the basis of these theories one can on the one hand derive design requirements and on the other evaluation criteria. Such an approach is discussed in the next section.

3. The MEGATAQ approach

The theories and approaches discussed in the previous section show that a proper evaluation of the success of telematic systems have to be based on the following conclusions:

- Evaluation should be viewed as an ongoing process, interwoven with the design process.
- Several levels of criteria and issues have to be taken into account: issues of individual human computer interaction and task performance, of interpersonal communication and group co-operation, of organisational processes and effectiveness, and of implementation strategy and adaptation tendencies.

The MEGATAQ approach [23] is based on these principles and has made use of earlier models (see e.g. [17, 21]). Through intensive consultation with a number of Telematics Applications projects, this approach has been honed and validated. Presently it is crystallised into a system of models, guidelines and tools, which have proven their value. It consists of three parts, an Evaluation process model, a Reference model and a set of evaluation tools.

As to the *Evaluation process model*, figure 1 presents the elements that may be part of an evaluation process. The ongoing evaluation process is here for the sake of simplicity trichotomized into 'anticipating assessment' (AA), "early assessment" (EA) and "operational assessment" (OA).

Figure 1: The MEGATAQ Design and Evaluation Model

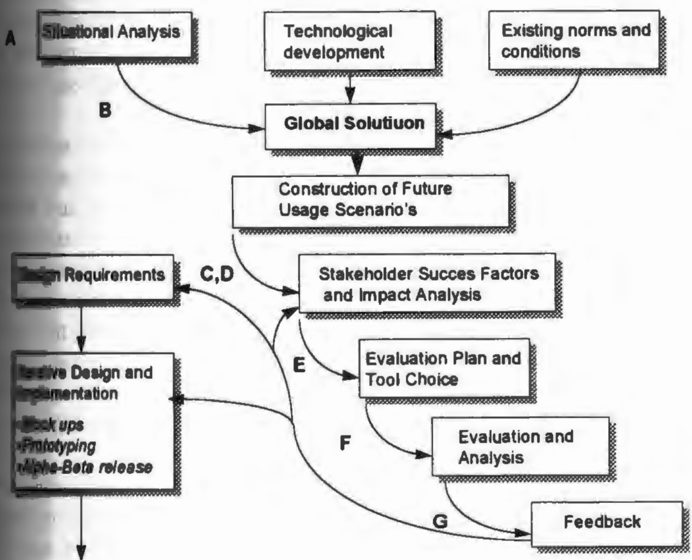


Figure 2 is a visualisation of the so-called *"Reference Model"*, identifying the theories based issues that could potentially be taken into account when planning a systematic evaluation of the intended and unintended implications of a new system. Since several of the above discussed theories point to the situatedness of technical systems and of their use, one should rather talk about the evaluation of the implications of a new socio-technical system (in stead of the implications of a telematic system).

This model is constructed along three dimensions, i.e. firstly along the dimension of *levels of interaction* (individual task and tool interaction, communication and group co-operation, organisational processes) and secondly in terms of an *input-processes-output-feedback* framework. Simply stated, system use implies the following three groups of factors:

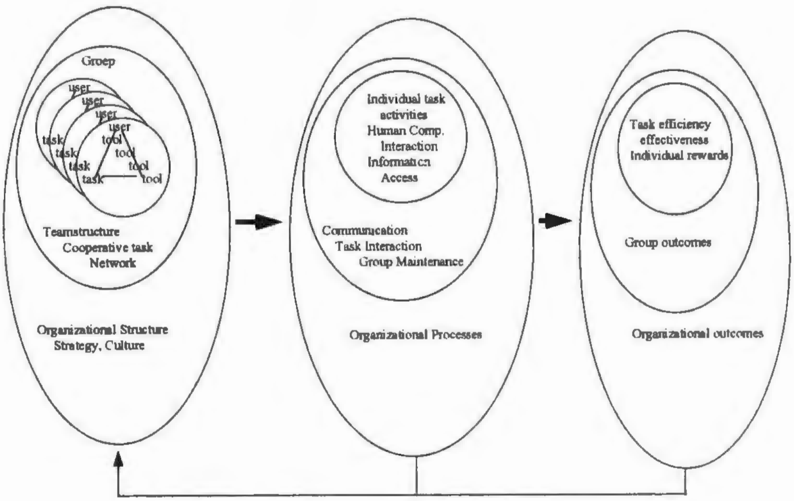
A The existence of certain *input* elements: context-of-use, i.e. people, tools, tasks, resources, (organisational) environment.

B The *processes* that take place, and where the input elements play a certain role. First, in the case of introduction of a new telematic system, the system is adopted and used, communication takes place and e.g. the tasks are redefined or the system itself may be adapted to the new situation. Secondly, task performance, co-ordination and group interaction takes place, in order to achieve the intended goals.

C The *outcomes*, to be divided in *first level outcomes* (individual, group and organisational products) and *second level outcomes* (intended or unintended side-results for individual users, for groups and for socio-economical functioning).

The third dimension is the *change* dimension: Introduction of a new technical system has potentially impact on the entire socio-technical system described in terms of the first and second dimension. Potentially change in all elements should be assessed.

Figure 2. MEGATAQ Reference Model



Not all factors are relevant in all cases. When designing a tele-information system for organisations, communication and group aspects probably do not require attention. When developing a system for citizen interaction, organisational issues are probably non-existing.

4. Guidelines

Based on the Evaluation Process model and the Reference model, the MEGATAQ approach has been developed into a system with the following elements and guidelines:

- A checklist derived from the Reference model (MARC) to identify relevant issues
- An evaluation process plan, derived from the Evaluation model
- Guidelines for the formulation of future usage scenarios, which can support the identification of design requirements and relevant evaluation criteria.
- Guidelines to identify different stakeholders and their succes criteria
- A set of specific assessment tools (most tools have been developed elsewhere) and guidelines for choosing methods and appropriate evaluation tools for the various stages in the design.

Evaluation process plan. The evaluation process plan supports the systematic identification and execution of the specific steps of the evaluation process. Roughly speaking the design and evaluation process can be directed as follows:

1. Analyse the present situation, ethnographically or through systematic tools, such as the context-of-use-part of the MEGATAQ Assessment Reference Checklist (MARC).
2. Formulate scenarios and identify stakeholders (see next section).
3. Identify the stakeholder success criteria and other evaluation criteria, using the MARC.
4. In case of future systems, do an anticipating assessment of impacts, based on the scenario's.

5. When the systems is being developed, make an evaluation plan and choose tools for 'early' and/or 'operational' evaluation, with the help of the Inventory of evaluation tools (see appendix 1).
6. Perform evaluations during and after the design process.
7. Analyse the results and apply them to the design process.

Guidelines for the construction of scenario's. The identification of user requirements for, but also of the success-criteria and of potential by-effects of a new system can be improved by formulating so-called Future Usage Scenario's, and analysing those scenarios. A (future) *usage scenario* is a description of an (as yet imaginary) setting, that is expected to become reality when the new system is implemented. The Reference model provides a framework for systematically developing such a scenario. It involves identifying the *users* who will be involved and their required characteristics, the *tasks* that these users will have to complete and their *responsibilities*, the new *application* or service and its expected use, the various types of *potential interactions* and *outcomes*, and the *context* in which the new application or service will be used. Guidelines for the scenario construction are part of the *MEGATAQ Usage Scenario Checklist* (MUSC).

Guidelines for the identification of user requirements and evaluation criteria. When one or more scenario's are constructed, an analysis of stakeholder success-criteria and of the potential impacts of the new system in the framework of that scenario can be made. The systematic discussion of the scenario results in certain user requirements. These requirements can also be 'translated' into criteria against which to evaluate the new system. Guidelines for the identification of these criteria are contained in the *MEGA TAQ Assessment Reference Checklist (MARC)*.

> Example; "Problem oriented teaching " is a modern type of higher education, applied in several universities and academies. At one universities this system is being developed to support the co-operation of students in the periods between the weekly meetings. It will enable the students to search in libraries, to co-author a document/memorandum, and to exchange messages. By applying the scenario approach it was discovered that the designers had not appreciated fully the role of a co-ordinator and the relationship to other communication media such as telephone and meetings at the bar. And by discussing the MARC with several stakeholders new criteria for evaluation were identified.

Guidelines for the choice of evaluation methods and tools

- *Early assessment:*

When a prototype of a new system is developed, first tests can be applied. This is often limited to the question whether the application (or new work situation) functions as it was planned and whether e.g. human interfaces are user friendly. Such tests are to some extent qualitative and informal in nature and performed in a usability lab, where speed of performance, errors and user reactions can be registered and analysed systematically. Calibrated questionnaires for subjectively appreciated usability aspects are also available.

- *Operational assessment:*

When a new work situation has settled and a technical system has been in operational use for a certain period of time, the impact on the functioning of the work unit can be evaluated. Issues of communication, social interaction, quality of work and organisational efficiency are at stake. The choice of the evaluation approach - i.e. of the aspects and tools, and of the data collection - depends on the type of questions to be answered, and on the time, money and expertise available. The aspects and dimensions identified through the Reference model are 'operationalised' in a toolkit that consists of two levels;

1. The MEGATAQ *Assessment Reference Checklist-for-realised effects* (MARC-R), which provides a first indication of the implications of a new work situation, based on the subjectiv ratings of key informants.
2. *Specific assessment tools*: For certain dimensions more precise and quantified assessment is possible through existing tools. Appendix 1 gives examples of such tools.

5. Applying the MEGATAQ Approach: Lessons Learned

The MEGATAQ approach has been developed in interaction with about twenty projects in th framework of the European Union Telematics Applications Program (TAP). The projects varied in sector, in stage of development and in the type of support required from the MEGATAQ proje Through the consultation contacts the original guidelines and tools have been adapted and refined. In the majority of cases the consultation has focused on three issues:

- advice on evaluation approach in general
- applying the MARChecklists, including stakeholder analysis and scenario formulation, to identif evaluation issues
- setting up a systematic evaluation plan

In some cases specific tools, such as the MUMMS and MMCQ, have been applied, but in other cases project specific questionnaires, interviews and other datacollection methods have been developed, bas on the general Reference Model.

The experience with the projects has also shown that in many cases the conditions for a prop evaluation (required by the European Union) are not well met. In several projects the participants w were directly responsible for evaluation and validation, had little or no evaluation (management) background or experience. At times, none of the consortium partners was explicitly responsible for th evaluation, or the interaction between the responsible partner and the other designing partners was ve limited. Resources (time, money) for evaluation were repeatedly rather restricted. In such cases the role of evaluation consultants includes giving guidelines and guidance concerning project management in general and setting up the conditions for adequate evaluation. It has become clear hoewever th systems tyhat have gone through systematic evaluation procedures are generally better than the one without

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...ndix 1: Examples of specific MEGATAQ assessment tools

The MEGATAQ tools are presented in seven clusters. From each cluster one or a few examples are given. Between ...rackets the total number of tools per cluster

...spection methods (8)	
...ristic Evaluation	Heuristic evaluation incorporates usability expert studies to identify any potential weaknesses in the design of an interface.
...erformance analysis (2)	
Human Reliability Analysis	HRA is used to measure the reliability of the interaction between man and machines by analysing errors.
...Behaviour analysis (3)	
...Diagnostic Recorder for ...bility Measurement ...UM)	DRUM is a software tool that provides assistance throughout the process of usability evaluation, by recording various aspects of user performance, such as duration of task activities and errors.
4. Effort and satisfaction (6)	
NASA-Task Load IndeX (NASA-TLX)	The TLX provides an indication of cognitive workload, based on a weighted average of ratings on six sub-scales.
...suring the Usability of ...ti-Media Systems (MUMMS)	The MUMMS is concerned with the users' perception of and satisfaction with six usability-aspects of Multi-Media applications: helpfulness, learnability, efficiency, control, affect and excitement
...ltiMedia Communication ...stionnaire (MMCQ)	The MMCQ is a questionnaire for assessing the quality of on-line communication such as video-conferencing
...Task aspects and relations (2)	
...tended Delft Measurement ...Kit	The EDMK or Quality of Working Life contains a set of well-tested questionnaire modules used to measure various aspects of work and organisation: Task characteristics. Relationships in the work place. Working conditions and terms of employment. Occupational characteristics. Opportunities to satisfy basic needs. Characteristics of work behaviour. Expenditure of effort
6. Network performance (11)	
...Perf	NetPerf is a software tool that can measure aspects of tele-communication network performance, such as speed of transmission and CPU time.
7. System usage and ...traction registration (5)	
...mputer logging	Automatic registration of the use of the system and of separate functionality
Coding schemes for ...ommunication content	Analytical schemes for coding the type of words or expressions in computer mediated communication

i

Panel

Design – Global Systems Demand Novel Methods

Róni Stamper (Chair)

Giampio Bracchi

Jan Dietz

Heinrich C. Mayr

GLOBAL SYSTEMS: A NEW FRAME OF REFERENCE

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At first our systems served only restricted communities with limited domains of discourse (algorithms, embedded stems and simple accounting and registration applications). The difficult human problems of meanings and tentionality were either irrelevant or resolved by organisational fiat. Our naive technical focus did no harm then but we still design systems as though nothing has changed.

Mere geographical dispersed does not make systems 'global'; the difficult problems arise when they span several ofessional, institutional, social, cultural groupings. Then meaning, intentionality and responsibility become difficult to pin down. (A major problem of this kind is open EDI.)

Our early experience taught us to ignore the social and human aspects of information, a mistake now itutionalised in methodologies, education, and the popular belief that information and knowledge are just like other commodities. Unfortunately, new frames of reference do not easily spring to mind when they are needed. As Kuhn shows, intellectual conservatism even affects science: Ptolemaic astronomy, phlogiston, caloric survived until their adherents died out and quantum physics met almost as much resistance. We are at such a point. Moreover, our own field relies more than others on deep, tacit assumptions which no-one can change without great intellectual comfort. The IFIP FRISCO Task Group of WG 8.1 encountered this problem and almost made the transition to a new paradigm before we finally retreated. With its immanent publication and direct relevance to our panel, I hall attempt to provoke a healthy controversy by citing some of the issues it should raise.

rstly, our profession uses some key concepts inappropriately where global systems are concerned. We still hear ague talk of "obtaining information by processing data" or "creating knowledge by distilling information". The RISCO definitions:

E33: "Information is the knowledge increment brought about by a receiving action in a message transfer", and

E36: "Knowledge is a relatively stable and sufficiently consistent set of conceptions possessed by single human riors."

hould, by explaining each difficult term in simpler language, leads us back to a few operationally simple, primitive otions. FRISCO takes us through "message", "data", "action", "actand", "pre-state", "post-state", "transition", predicator", "language", "symbol", "entity, etc until finally we come to "thing" and

E1: "A thing is any part of a conception of a domain.

an impossibly vague idea on which to base a genuine science of information.

Take physics as our mentor, and see how it relates even "quarks" and "momentum" to operations on materi objects, its primitive notion. But "thing" is too vague a term and conceptions are only accessible through individ introspection. FRISCO nearly used a good primitive, the notion of a sign, a physical phenomenon which stands fo something else, as far as the people using it are concerned. Signs can be defined operationally, leading to man exact and diverse definitions of information, just as physics refines the vague notion of the size of an object.

Global systems, require us to acknowledge the central role of those who interpret information and the notion of a sign allows that. All information is utterly dependent on some social group and its culture. Our historically-ro technical view of information ignores the obvious.

A semiotic framework, mentioned but not seriously exploited by FRISCO, gives us a balanced view of informati and its properties on six level, three technical and three concerned with human and social aspects:

Physical tokens and their costs

Empirical or statistical properties of sets and sequences of signs (communications)

Syntactics - sign-structures and their transformation (software and data)

Semantic properties of signs in relation to what they stand for (meaning)

Pragmatics of signs used by people to accomplish ends (intentionality)

Social results of interpreting signs and the value obtained.

Interestingly, FRISCO'S central chapters deal only with syntactic problems.

Globally we handle the technical issues well but have no systematic way of treating human issues. On social lev we have lost sight of the fact that information creates value only when it results in changes in knowledge by altering obligations, beliefs, values and perceptions. These effects go beyond anything technology can explain, and global systems often fail because our designs have not taken them into account. This view also makes clear that knowledge is not another commodity but an intrinsic part of the social fabric.

Currently we also ignore pragmatics and semantics, designing information "plumbing" systems to store and distribute sign-tokens. No attention is paid to those responsible for circulating signs and what their intentions are. This narrow technical focus serves us badly today. On the wide stage, it suits the anonymously powerful but threatens open, democratic institutions; and on the narrow stage, it undermines trust within or betwee organisations. Lack of trust, which flows from lack of openness, is hugely expensive but not accounted for on the technology invoice.

The most intractable of these three problem areas is semantics. Our antiquated, information plumbing methodologies side-step this issue. We deal with the extraction, storage, manipulation and dissemination of sign-tokens, ignoring their meanings. FRISCO is aware of semantic issues but, when it comes to its illustrative case-study, nothing is said about meanings. The design, you will see, arranges the "plumbing", telling us how to structure and process sign-tokens, but remaining silent about their meanings and who is responsible for making them and interpreting them. The first hurdle to overcome is the invisibility of the semantic problem; our methods presume that information has intrinsic meanings, ignoring the central role of communities and cultures in making and providing those meanings.

The semantic issue calls for a painful intellectual shift. FRISCO confronts the ontological assumptions implicit in any methodology but then takes refuge in a mixture of objectivism and mentalism, called "constructivism". With the objectivists FRISCO believes in a reality that exists independently of any observer, and with the mentalist concedes that our only access to reality is a subjective one via our own conceptions. The trouble is that believing in an independent reality and negotiating agreed conceptions about it both depend on the use of information which therefore demands a prior explanation. We can do this by noting that signs take their initial meanings from the cultural regularities shared by their users. People then use information to bootstrap a more elaborate reality for which they must take responsibility. Designs for global systems must acknowledge that information cannot simply record and model reality, it is used to construct it.

Towards Global Architectures: Designing Integrated Information Systems

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The globalization of business and recent technology developments have added to the complexity of desig and operating the IT architecture. Multiple sources of information, different work practices and softwa procedures, independent choices of standards have created the need for integrating technology resou Furthermore, the implementation of a global sharing of resources imposes additional costs related to integ legacy systems as opposed to addressing requirements *ex novo*.

Information systems integration has traditionally been studied in database conceptual design (cf. Batini 198 However, the interest towards integration has recently broadened to other research areas, primarily obje orientation, reuse and representation of viewpoints in software engineering (cf. Finkelstein et al. 1994). The support to integration activities provided by traditional methodologies for database design is not suffic satisfy current requirements in designing a global IT architecture. Sharing IT resources involves not only but also the procedures accessing and manipulating data. Also, classical integration suggests the reconcili of data discrepancies into a unified representation, while different parts of an overall IT architecture may requ to keep their own solution, at the same time being able to communicate (cf. Easterbrook 1991). Organiza constraints such as existing standards and consolidated practices for data manipulation may limit freedo solving conflicts or even impose predetermined solutions. For example, tasks within a production function may use codes for products that provide indications about their production process, while within R&D codes may relate to the different projects. And both functions might need to communicate codes, without renouncing their own standards. However, a lack of standardization and an excessive endurance of legacy systems may have negative cost implications

Despite its controversial definition, the term IT architecture is used to refer to aggregate technical and organizational choices that affect subsequent development and operation of technology resources over time (cf. Zachman 1987, Sowa and Zachman 1992). While an isolated software project, or a hardware upgrade can be associated a price, the cost implications of architectural choices are more properly quantified as a percent the overall IT budget. The technical complexity of architectural choices and their aggregate cost conseque are reflected in a traditional interest towards understanding the technical alternatives determining costs.

The issue has recently come to the fore as companies have started to implement client-server archite solutions. Since the early 1990s, the shift to client-server has initiated a debate on the cost requirements of the new architectural paradigm. Opportunities to integrate legacy technology resources, less exp decentralized hardware, and reduced needs for ad-hoc application development had raised expectations for overall reductions of the IT budget. Subsequent accounts on actual costs have most often reported significa budget increases, seriously disappointing initial prospects.

Cost analyses of technical choices have highlighted numerous design trade-offs primarily related to the appropriate sizing and location of computing resources within an IT architecture (cf. Guengerich 1992). One the most widely discussed design trade-off is described by Grosch's law, recently reformulated as "it is mos effective to accomplish any task on the least powerful type of computer capable of performing it" (Ein-Dor 1985). A number of technical factors would instead work against decentralization. First among them, communication cost can be significantly higher in a decentralized architecture, due to a more cumbersome data retrieval and consolidation in distributed transaction processing (cf. Lee et al. 1994).

While pointing to the relevant technical cost trade-offs, previous analyses have failed to consider management costs, which can be greatly dissimilar across different IT architectures. Ahituv et al. (1989) distinguishes two separate distribution policies, technical and organizational, privileging technology and management considerations, respectively. Management costs represent a relevant dimension of organizational policies for choosing an IT architecture and have been empirically found to shift the balance of technical trade-offs (cf. Dec 1996, Simpson 1997a and 1997b)). Distributed architectures have in fact been extensively adopted in organizations only in the early 1990s and some of the expected cost reductions have demonstrated elusive.

The organizational argument to explain these failures is that the overall cost of a distributed architecture depends on organizational requirements, which may or may not favor distribution (cf. Guengerich 1992). For example, the reengineering literature has advocated the necessity of aligning organizational structure and technology and has contributed to creating the belief that a flatter, process-oriented and more networked organization would be best served by a distributed IT architecture (cf. Hammer and Champy 1993, Jarvenpaa and Stoddard 1993). However, the relationship between the overall costs of an IT architecture and the structural features of organizational processes have not been investigated. The few empirical results that have been published present absolute costs comparisons between centralized and client-server architectures and do not discuss the impact of process features on findings (cf. Simpson 1997a and 1997b).

Traditionally, organizational requirements and resulting architectural costs are tied by design methodologies that incrementally translate requirements into technical choices (cf. Aue and Breu 1994). Design phases are relatively consolidated, but each one of them has been primarily studied in isolation and often further partitioned into sub-phases (cf. Alter 1996). For example, requirements design has been addressed both in the information system and organizational literature. The latter has typically viewed information processing capacity as a factor of organizational performance, with limited attention to technology costs incurred to support different levels of information requirements. The information system literature has dealt with representational and integration issues of organizational requirements, leaving costs as an issue for subsequent design phases more directly involved in technology choices (cf. Coad and Yourdon 1991).

An aggregate perspective evaluating the effect of structural properties of processes on architectural costs has rarely been taken (cf. Francalanci and Piuri 1998). This analysis should be aimed at understanding how cost trade-offs shift when management costs are accounted for. The rationale for this analysis should be to verify the assumption that client-server and, more broadly, the decentralization of computing resources involve overall higher costs. Disproving this assumption would provide evidence to support the traditional design approach that fits architectural choices to organizational requirements, despite possibly shifting cost trade-offs when management costs are accounted for. An empirical approach would be best suited to provide tangible evidence to the need for a more precise assessment of the cost of new architectural technologies.

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The OER paradigm for designing and engineering global business systems

Position paper for the IFIP World Congress 1998 panel "Design: global systems demand novel methods"

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Introduction

Does designing global systems demand novel methods? Yes, indeed it does. But in addition, there are two remarks to be made, pertinent to this question and answer. The first one is, that it is necessary to become more precise and strict in distinguishing between the two categories of systems we are dealing with, viz. *business systems* and *information systems*. The second remark is, that in fact we needed these 'novel methods' for adequately designing and engineering business systems for a long time. Put differently, the methods currently in use, blur the distinction between the category of business systems and the category of information systems, leading to such erroneous views as that a business system is a kind of information system (notably in case of so-called information intensive organisations), and that information systems are subsystems of business systems. However, business systems are a special kind of *social* systems, the elements of which are social actors (i.e. human beings exerting their social capabilities) who do things because of assigned authority and with according responsibility. Quite differing from that, information systems are *rational* systems, the elements of which are rational actors (i.e. human beings exerting their rational capabilities, or information automata).

Next to this distinction between business systems and information systems, it is equally important to distinguish between two system orientations, and to be aware which orientation one takes at any moment, while being involved with designing or engineering (either business or information) systems. These are the function orientation and the construction orientation. Taking the *function* orientation means being interested in the functionality and the external behaviour of a system. It includes using a black box model to understand the system, as well as applying the technique of functional (de)composition to refine this understanding. Taking the *construction* orientation, on the other hand, means being interested in the internal construction and operation of a system. It includes using a white box model to understand the system, as well as applying the technique of constructional (de)composition to refine this understanding.

It should be nothing else than forcing an open door to state that for (re)engineering, i.e. technically redesigning, a system, one needs to take the construction orientation and to apply and possess the appropriate constructional kind of knowledge. Note however, that in almost all BPR projects the dominant and sometimes even exclusive orientation taken, is the functional one; the dominant talk is about business opportunities, critical success factors, performance indicators, functionality, added value chains etc.

The OER paradigm

The paradigm shift we need to make is, to abandon this dominant functional thinking, to discover firstly that it is very well possible to talk about the construction of a business system or an organisation, and secondly that it is very sensible to do this, that it is actually the only way to abstract fully from realisation or implementation issues. In order to design global business systems, one needs to understand the (constructional/operational) essence of every business system, which is the entering into and the complying with commitments among social individuals. Only then can one make the useful distinction between business processes and logistic processes. Only then can one acquire the right design freedom, in both the informational and organisational sense, for designing new ways of 'realising' business systems.

In the past seven years, we have developed at Delft University of Technology a new understanding of the core concepts of a business system as well as of the relationships between them, these core concepts being: communication, information, action and organisation. The research carried out has resulted also in a methodolgy for (re)designing and (re)engineering business systems, called DEMO (Dynamic Essential Modelling of Organisations)[1]. The core of the DEMO theory and methodology is the *OER paradigm*. The word "OER" is a Dutch word meaning "primal" , "original", "the very first". In this meaning OER refers to seeking to understand the essence of a business system, that what remains after disposing of all information technology stuff and all organisation technology stuff. Next, the letters "O", "E", and "R" stand for the three phases of the DEMO *transaction*, which is the core notion of the OER paradigm, integrating the concepts of communication, information, action and organisation. The three phases are the order phase, the execution phase and the result fase. The order phase is a so-called actagenic conversation between the initiator of the transaction (the customer) and the executor (the supplier), the execution phase is the actual doing by the executor of what was agreed upon in the order phase, and the result phase is a so-called factagenic conversation between the two actors, of which the successful completion is the acceptance by the initiator of the produced result. The DEMO transaction concept has a sound foundation in language philosophy and social action theory, and has effectively been applied as the building block of business processes, both in traditional organisations and in virtual organisations. The OER paradigm combines this transaction concept with the distinction between business systems and information systems, and with the construction orientation towards business systems. Therefore, this concept seems to be the appropriate backbone of novel methods for designing global systems.

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1 A recent publication is: Dietz, J.L.G., J.B.F. Mulder, Organisational transformation requires constructional knowledge of business systems, in: Proc. 31st HICSS, IEEE Press, 1998.
A previous publication is: Dietz, J.L.G., Modelling Business Processes for the Purpose of Redesign, in: Proc. IFIP TC8 Open Conference on BPR, North-Holland, Amsterdam, 1994

Information system design integration in a virtual enterprise environment

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Position Paper

Though often seen with concerns, the on-going globalization bears tremendous challenges and changes for large, medium and small sized enterprises as well as for developers of information systems. Large enterprises try to take up theses challenges mostly by entering long-term strategic global co-operations or even mergers (think, e.g., of the recent merger of Daimler Benz and Chrysler). In contrast to that, small and medium sized enterprises (SME's) might to cope with globalization by participating in *dynamic networks and virtual factories*: Alliances which are limited in time but not in distance and which end after having produced the intended services will allow them together to *exploit market chances* that are hardly accessible for a single enterprise. Within such a constantly self-modifying environment all processes (organization, production and logistics) have to be controlled, evaluated and optimized continuously. This requires efficient simulation and optimization tools in connection with automated mechanisms for Workflow Management, Production Planning and Control, Computer Aided Engineering etc.. For an effective use, all these components have to be connected to each other so that well-defined interfaces are needed that allow for an integration of the different (process) models and views underlying the various eomponents. Moreover, *reference models* will have to be developed and used in order to achieve the goal of capturing and sharing the knowledge and data of the partners within a virtual enterprise. Conventional design methods do not provide comprehensive means for such an integration.

The question now is, on which level of design that integration should be carried out. At a first glance, the conceptual level, i.e., the level of semantic models like that of object oriented analysis (or classical ER models) might seem to be the most appropriate one. However, since there is a variety of

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metamodels for that level, the partners of a dynamic network likely might come over wit models/designs that are built/formulated using different metamodels. Consequently, integrating these models requires a preceding homogenization, i.e. the models have to be 'translated' into an arbit but unique metamodel. This is a non-trivial task, especially because of the fact that the semantic poti of different metamodels usually is not equivalent.

In addition, both, decision makers and end users within a dynamic network, should be put into position to judge on and to validate the common view resulting from integration. Experien practice show, that such a validation poses problems. This is even true for conventional 'stand-i (single enterprise) environments: it turns out that the use of relatively abstract modeling notions, that common to OOA approaches, makes the design of complex information systems less transpa end-users as it is pretended in theory. I.e., the level of formalization that is intrinsic to these approache is too abstract as being appropriate for the (necessary) validation by the end users (despite of the fa that modern methods are often argued, mostly by their providers, to produce models that work very fin as a communication medium between designer and end-user).

To overcome these problems we propose to place in front of the conceptual design a phase which w call *conceptual predesign*[2]. Whithin that phase relevant information is collected mainly in natu language form and 'translated' into the notions of a lean but powerful semantic model called KCP (Klagenfurt Conceptual Predesign Model, [KoMa98]). KCPM predesign schemata are represe form of glossaries that work as a detailed scratch pad for a given universe of discourse (UoD) and th correspond to the patterns practitioners are used to deal with. These glossaries are a rather practicabl means for integrating entries from different views.

On the other hand, KCPM is designed for far-reaching automation of the (conceptual) desi process[[FKMMW96], [FKMMW967]: Actually we can offer a set of rules for the mapping of KCPM schemes onto the static model of UML [BRJ 97], i.e. the integrated view may be mapped to a larg extent automatically to the conceptual level. However, our goal is not only to simplify the mapp between conceptual predesign and conceptual design, but also to automate the process of getti th

[2] This phase again is called *conceptual* since it works with a - though less abstract - conceptual model.

pttdesign schema itself. This means, that we aim at an automatic extraction of the predesign schema entries from the end-user's natural language requirements statements.

In turn, (automatic) mappings from different conceptual metamodels to KCPM, might substantially facilitate the homogenization process mentioned before (if there are conceptual models/schemata for the systems to be integrated). Developing such mappings, however, is more a piece of diligent work than a hard research problem and will be carried out by student projects within the next future.

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Teleworking and Virtual Organisations

Teleworking and Business Reengineering: Lessons learned from Operating Systems development

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Abstract: First an outline on Teleworking (TW) and its specific needs is presented. Then a review of the evolutionary development of Operating systems is given, focusing on the current Client Server Architectures. It is explained, that a process oriented view, as it is typical for Client Server Systems is also needed in order to handle TW and to manage TW oriented jobs. Currently the demand for TW-jobs is much higher than the number of jobs offered by employers. One reason is, that from a company's point of view , there are no entirely convincing arguments to introduce TW lacking in acceptable trade-off concerning costs. However this can be overcome, if a (radical) business reengineering process is applied on hierarchical structures: most enterprises still are organised by functional treelike structures. This has much in common when Operating Systems, based on a hierarchical design and structured by layers have been modified towards autonomous subprocesses (clients) demanding services from other independent processes (servers). These similarities are appealing and we can learn from these experiences made. In this context we also might discuss, whether TW is just a mode of operation or whether it can be seen as profession of its own having impact on appropriate curricula.

Keywords: Teleworking, Telecooperation, System Design, Business Reengineering, Distributed Systems, Client-Server architectures

1.Working definitions for OS and TW

1.1 Operating Systems (OS)

In the Encyclopaedia of Computer Science [ECS93] we find the following definition of a Operating System (OS) and ist design goal:

"... a set of software extensions of primitive software, culminating in a virtual machine that serves a high-level programming environment and manages the flow of work within a network of computers".

This definition emphasises the close connection between hardware and that bulk of software called OS. It does not reflect the interests of people who have to work with such systems directly and have a preference to the following more general definition, as it is stated in [PBH73]:

"An operating system is a set of manual and automatic procedures that enable a group of people to share a computer installation efficiently".

The appealing aspect of this definition is

(i) it includes people who are affected, independent of being customers or persons operating directly on a computer. The primary goal of an operating system therefore is convenience for the user. The definition focuses on the overall purpose of an OS leaving technical aspects aside and does not refer to implementation and structural details.

(ii) if one regards "procedure" in the more general and original meaning, it also includes any action, which contributes to the purpose of the system directly, regardless of whether the action is performed by means of a computer or by using other resources including actions initiated by users.

As a consequence we could look at an OS from its (human) clients point of view. Then we can make a classification of OS depending on the mode of operations they are providing, e.g. batch processing, time sharing, distributed processing etc. and can discuss which modes are more or less suited to the individual needs of the customers.

This immediately leads to the analogy between an OS and the organisation of a company. We can use operating systems as models for such organisational aspects. The most suitable organisation has to be chosen depending on the needs of customers and according to the mission of a company.

the other hand, a given organisation specifies and restricts the way customers have access to the company and how employees can interact internally in order to fulfil their tasks. Later on we explain, why Client Server oriented architectures are especially suitable to be used as convenient models for mastering business processes. This point of view will be discussed in the sequel.

1.2 Teleworking (TW)

The term 'Teleworking' (TW) is a very broad scale expression and naturally there is no unique definition. It can mean taking employees out of the workplace and putting them back in their homes. But this restricted view refers rather to what is called home working. TW can mean transferring back-office work to remote data processing centers or outsourcing it altogether. In the latter case however the relationship between the company and its employees is weakened or eliminated. In any case TW uses information and communication technologies to practice remote working of some kind. So telework - as it is understood currently- is not an occupation of its own, but a method of working and is developing as technologies develop. In the last chapter (5) we come back to this interpretation and we will promote a more general view, understanding TW as profession of its own too. Another important feature of teleworking is flexibility in the sense of flexible staffing and recruiting from a wider labour pool and to cope efficiently with fluctuating workloads.

A very broad definition or rather description of TW and therefore commonly accepted is as follows:

> *Teleworking means the use of computers and telecommunications to change the accepted geography of work.*

Teleworking persons (TWP) work partially within the company 's office space and partially outside at their home office and they have to interact with either group, other TWPs and colleagues who do their job in the traditional way. The definition leaves open when, to what extent and where this distributed work is done.

We see, that TW refers – from a narrow point of view - to the "mode of operation" of employees of a company and the "interfaces" between the individual workers. If we want to address TWP who are acting as self-employed persons we have to expand this view to more general aspects focusing on "changing the geography of work" and on the implied communication paths.

In the sequel we want to discuss the following related aspects in particular:

- Assuming a hierarchical organisation structure for companies as the most common one, based on "functions" (i.e.: purposes of the departments), does it meet the needs of TW or has the management to restructure a company radically as soon as TW is implemented? Is such an organisation suitable if workload and efficiency of TWPs has to be measured?
- To what extent is the evolution of OS mirroring the mutual needs of people and companies? Which analogies between the internal structures of an OS and the structures of a company can be drawn? Can we learn from the experiences drawn from the evolution of OS?

2.Some major steps in Operating Systems Design

2.1 First steps towards an organisation

At the very beginning there was no distinction between what we call system software today and between programs, which are user supplied in order to perform some application on a computer. So let us make a big jump into the late 1950s and early 1960s, when OS started already to exist.

The following aspects characterise the systems of that time:

1. there is just one processor and in particular one common system clock
2. batch oriented processing of tasks was dominating.

Later on the concept of spooling was brought in by the use of interrupts and by providing the possibility of overlapped task execution, as long as they are independent from each other. This brought in additional problems followed by an extensive discussion on how to synchronise parallel processes.

Although there was now a clear distinction between system oriented tasks grouped together as what we would regard as an OS versus user oriented tasks, the situation was still uncomfortable in the following sense: Because such early OS were more or less unstructured and programmed like spaghetti code, there was no strict separation between the individual sub tasks an OS had to perform. At any time any subcode of the OS could invoke any other part of the OS. As a consequence running a user program always required the whole OS to be loaded in advance.

If one transfers this situation into a task an employee has to do, we can recognise: if an enterprise is structured as monolithic OS are, then no person could take away even primarily isolated tasks in order to perform them somewhere outside of the company. Whenever there is a need to have access to the company's resources it is very likely that access to other resources and extensive communication with co-workers including frequent synchronisation would be necessary. The amount of these interactions can not be predicted. In this scenario TW might not be possible at all or could cause troubles.

[redacted]erarchical System and Functional Orientation

However, focusing now on the structure of an OS and its logical design, we are interested in concepts in order to improve the reliability of such systems and to improve its internal structure. A major step in the evolution of OS was the idea of structuring them into layers. This was a direct reflection of general concepts of software design, better known as "stepwise refinement", "information hiding principles" or generally "structured design of software".

The various layers are separated from each other as much as possible and information exchange between the various layers is provided by a defined interface. In particular the interface between the OS itself and the user program becomes relevant: the Application Interface (API). Depending on the operating system these interfaces were weak or strict and the best known layered approach we can find in the literature are implemented in the THE operating system [Dijkstra1968] or the Venus System [Liskow1972].

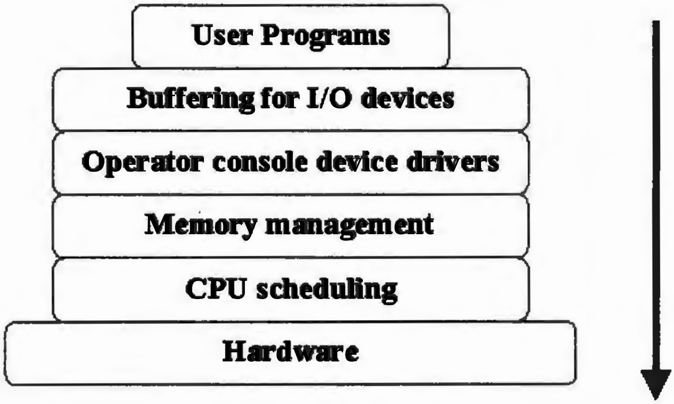

Figure 1: THE layer structure

If we transfer this layered approach directly to companies and the way they are structured we observe:

There is a well defined structure in the company and typically it is a hierarchical one. It provides layers and the components of its layers - the nodes of the resulting hierarchy, also called organisational chart or organigramm for short - are responsible for doing some specific and well defined task. Each component (department, functional section) may delegate tasks to nodes below or may call for assistance to nodes of the lower level layers too. The communication and therefore the way how data is submitted to or returned by the various interacting departments is standardized usually by the use of well-defined forms. An association with the API of an OS comes into mind immediately.

From OS we can learn, that this approach is not as efficient as it is supposed to be. A strict separation and the resulting interfaces work fine in theory, but in practice there are intrinsic problems derived from the demand that the layers should be arranged treelike reflecting a true and consistent hierarchy for all the needed functions.

A typical example for such intrinsic difficulties is given by a File System. A File System should hide the underlying mass storage architecture from application programs, which must have access to data stored on the disks. The File System also should be replaceable by another one (think of FAT file system and the NTFS used within the Windows NT- Operating system).

Consequently the File system should be rather on top of the software hierarchy. At the same time, the OS itself, using virtual memory management must allow some of its low level components, the kernel and/or device drivers, to have access to the main memory extensions held temporarily on the disk, e.g. by paging techniques. Consequently the file system must be subdivided into a low-level component and a portable part located rather on top of the hierarchy. This increases the number of interfaces and slows down performance because of the overhead. The low-level component itself must have access to system dependent drivers and is probably placed somewhere else within the overall structure and a strict tree can not be maintained.

Another weakness is the emphasis on a static view: which functions are allowed to call other functions directly. But OS have to control the co-operation of processes and this implies other organisational structures, which are more suitable to handle such a co-operation and to synchronise sequences of events Think of the following example. A new employee has to be hired. A lengthy list of departments and various subdivisions of a hierarchically and functionally organised company is getting involved in handling this matter. The following activities have to be done among others: specifying the required skills, advertising, interviewing and testing, registration for insurance, preparing everything for the payroll, assigning for training, allocating office workspace, opening computer accounts etc. It is likely that the "advertising task group", normally responsible for placing advertisements for product promotion will belong to a different branch of the organisation from that to which the IT department belongs. It is the IT department which is responsible for providing the IT resources to the new staff member. It will take some time and extra effort until the new staff member file gets all the endorsements and it can be transferred to the IT group with the instruction to open a new account for the domain in question. People from the advertising task force cannot give orders to the IT- group and the same is true for the interaction between the general administration, which is handling the payroll matters, and the division which prepares and organises training courses. So the file goes up and down the hierarchies and provokes many interactions, which are a result of the underlying organisational structure instead of obvious and task oriented needs only.

Transferring this again to the situation of a TW we find: if an company is organised strictly in a hierarchical manner and if the (static) functions of its units are the dominating organisational units, then we encounter similar problems as they exist in designing the interfaces for a hierarchical OS. There are too many needs for access to other units when climbing up and down the various levels and many of these steps are necessary because of the chosen organisation rather that by the real needs of the case in question. Many interfaces and time consuming interactions are involved. This reduces the degree of flexibility of a TW and its potential power. The frequent need for interaction with others demands people to work within the company where these interactions occur. The number and kind of tasks, which can be performed by TW remains restricted and may inhibit TW completely. We will achieve a substantial change if we adopt the following process oriented approach: Declare an experienced and reliable staff member as responsible for the task "hiring a new employee " and give him or her the rights ("privilege") and authorisation to call for assistance from other task oriented groups whenever it is necessary. This person attends to the matter from its very beginning up to the final event of welcoming the new employee. In other words, assign the privilege to act as a client and call for the services of others in order to fulfil the initiated task, create the process "hire people". We come back to this approach in the next chapter.

2.3 Client Server Architecture and Business Process Orientation

As we have pointed out already, organising an OS purely from a static point of view means ignoring running processes in favour of their static descriptions, which are called programs. Comparing this against organisational forms for companies we can recognise: a functional and in particular hierarchical organisation structure reflects a static view. It is not process related. It shares the same problems as we have mentioned for hierarchically structured OS.

In order to overcome these problems two closely related tendencies can be mentioned:

> As far as OS are concerned, the idea of distributed systems leads to client server (CS) oriented architectures. Generally speaking, a distributed system is a collection of independent computers that appear to the users of the system as a single computer [TAN95]. In this case parts of the operating system run on a collection of networked machines and the resulting processes have to co-operate. We see as a specific consequence that there must be a single global inter-process commiunication mechanism, which allows the necessary communication between the running processes. Users of such an OS should not have to be aware, that the various processes are performed by multiple and distributed processors. They see the whole OS acting as a virtual uniprocessor.

The comparable equivalent to companies is an orientation towards distributed units, which perform some tasks and have to co-operate mutually. A customer is not aware, that business processes, which are needed to handle his demands, may be performed by a collection of distributed but coupled units, he or she sees the company as a whole: "one face to the customer".

As described in [MUE98] process orientation of companies is a feasible way in order to enable TW and to bypass many problems, which would occur, if TW were forced onto a hierarchically organised and functionally oriented organisation without any further restructuring. The above example "hiring a new staff member" exactly reflects this observation.

Therefore we recall major concepts of such design principles for distributed operating systems, in particular those, which provide interesting analogies to TW within a business process oriented company. It is sufficient to recall the principles of client server oriented systems, which do not fulfil all the general criteria characterising a true, distributed OS. However we can learn from the experiences made and solutions provided for client server architectures, because there are many analogies to business processes.
The idea behind such a client server model is to view the OS as a group of co-operating processes exchanging timing signals and such like. Some of them, called servers, offer services to others, called clients. Whether a process is a server or a client is not a permanent property, it depends only on the (changing) relation " server offers and performs a service demanded by a client".

The distributed components of a client server oriented OS are organised in order to perform sub processes autonomously and in parallel. Whenever a process has to interact with another process, it does this by sending messages via a kernel by means of e.g. Remote Procedure Calls (RPC) or (directly by Local Procedure Calls (LPC) exchanging a minimum amount of data. The specification of RPCs also includes protocols used to send data over a network.

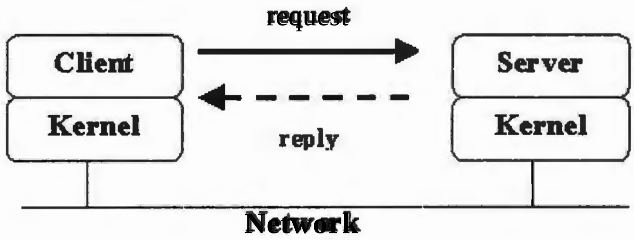

Figure 2 General client server model

Figure 3 shows a situation where clients and servers run upon one processor and communicate via just one kernel. However the general model leaves open, whether there are more (identical) kernels and the servers and clients are distributed and linked together by a network, as it is shown in Figure2.

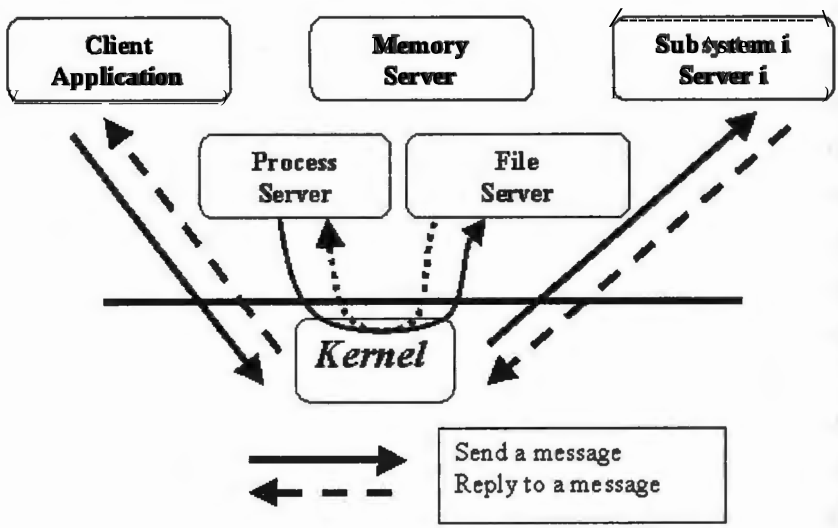

Figure 3: Basic structure of a C/S Operating System with one kernel

One major point is that the exchange of signals and the RPC mechanisms enable the subsystem responsible for performing the various tasks to be run elsewhere.

If such processes run within the system, which hosts the kernel too, then they share a common clock and the same physical main memory. In this case synchronisation is easier and also the complex remote procedure call mechanisms can be replaced by the faster and slimmer LPCs because of the underlying reliability and because of reduced security concerns. These LPCs even can bypass the controlling OS kernel and may send signals and messages directly to other subsystems residing on the same host.

If subsystems are located outside, driven by other processes and neither sharing the hosts memory nor having a common clock, than the Remote Procedure Call mechanisms provide the desired interfaces for communication and acknowledgements of submitted data. (We restrict the discussion to RPCs and do not discuss here more advanced concepts for what are called Object Request Brokers, as there are OLE, ActiveX or the CORBA specifications)

In either case processes run in parallel, exchange signals, data or referenees (pointers) to data as ^riggly as possible but as much as necessary to cover all essential security aspects.

3 The Client Server paradigm as model for Teleworking

We find that the C/S paradigm is ideally suited to TW as well. Let us regard a company as an environment providing a collection of business processes. We also leave open where these processes are performed, locally or somehow distributed. From this point of view remote processes are performed by TWPs and these persons have to communicate with others analogously to the C/S model. Interacting protocols and conventions have to be provided too. Specific commimication paths have to be made available for dislocated remote work, but people should work autonomously as much as possible and should try to minimise the need for exchange of data and synchronisation signals.

The C/S paradigm defines clearly "client" and "server" but it does not say that a piece of software always is of type "client" or is of type "server" for ever. Although some software typically runs as a client (e.g.: mailing program) demanding processes from a dedicated server (e.g.: mail server), the attitude or even the mutual relationship between two pieces of software may change also. In the case of TW we find a similar situation. Co-workers as clients hand over a task to a TWP demanding a specified service. But the TWP in turn, now acting as a client, may need and ask for services of other co-workers independently of whether these services are provided by other TWPs or traditionally within the company's office area. The overall and main message is: clients demand the performance of business processes by servers and both sides rely on well-defined communicating paths. Introducing TW therefore presupposes process orientation and an appropriate computing environment as well. We come back to this in chapter 4.2 again.

4.Radical Redesign from scratch versus stepwise approach

4.1The crippled approach: Win 3.x upon DOS

There is much more that we can learn from the history of operating systems. When Windows 3.x was implemented the designer had to obey backward compatibility to the former DOS operating system at any price. Although Windows 3.x was successful from the commercial point of view it failed in terms of structure, efficiency and stability and many customers had to suffer from its structural deficiency. So to speak: putting Windows 3.x on top of and partially aside DOS is a crippled approach. To some extent the situation remained unchanged when Windows 95 was announced and brought into the market. The intrinsic problem is that the specification and implementation process did not start from scratch or by means of a radical redesign. The commercial conditions have forced the developers to take compromises and the results are well known. However concerning Windows NT, the situation is entirely different. This operating system is based on a radical new design giving up a strict backward compatibility to any predecessor and basically is oriented on Client Server philosophy.
As stated before already, we regard the CS concept as a convenient and suitable model for TW but we can also learn from the evolutionary steps the various systems went through:

On the one hand there are various technical and structural needs, on the other hand there are customers and clients who have a preference for stepwise changes. Providers are interested in a sound technical solution as a necessary precondition for long term success on the market and return of investment, users are anxious for new versatile systems whilst hesitating to accept the accompanying changes. Figure 4 shows the structure of Win 3.x and its structural deficiencies.

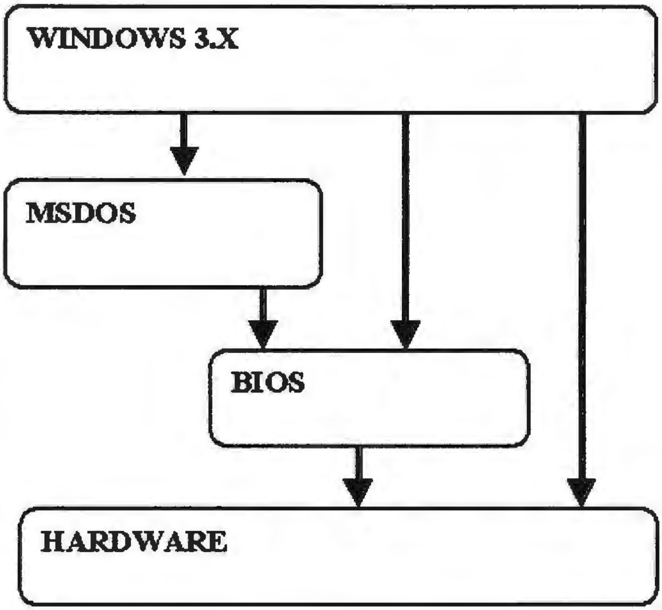

Figure 4; Structure of Win 3.x

4.2 Analogy to Teleworking

Principally a radical process oriented redesign would end up in changes of organisational structures from hierarchical to flat. But commercial aspects do also count and acceptance by customers must not be ignored. Both arguments suggest a smoother approach towards the right direction. If we transfer these observations to TW we find: TW demands process orientation in the longer run and therefore a company introducing TW must be prepared to undergo a business process redesign in order to avoid a crippled and inefficient internal structure. But all these approaches have to be prepared carefully and must be done stepwise in order to lead towards a feasible solution which is equally accepted by all partners: the employees and the employers as well.

Currently the major demand for TW oriented jobs comes from people expecting more convenient working conditions, e.g. reduced travelling costs and/or time spent for daily commuting or flexible arrangement of working hours due to individual demands and needs. Therefore they are prepared to accept changed working profiles too. But such changes also affect all the co-workers who still want to do their job as usual within the company. As far as the management of a company is concerned we have to observe; as long as there are no more convincing arguments backing the claim that introducing TW to the company would also improve the overall performance on the market, employers will hesitate to create and provide TW- oriented environments Approaches to push TW just by augmenting the demand for TW will have limited success, as long as the supply of such jobs from companies is not increased. The management of companies must have good reasons to make steps toward that direction. Many of the listed or reported benefits of TW for employees are compensated by other disadvantages and are, as a matter of fact, not really convincing. For an extensive discussion of these problems the reader is referred to ([MUE98], [SONN97]).

The answer to the revealed dilemma is: first a company has to reengineer its business processes mainly for commercial reasons. Reengineering a company's business processes ultimately changes practically everything about the company, because all these aspects - people, jobs, managers and values- are linked together.Hammer [HAMM93] refers to it as "the business system diamond" and visualises these interdependencies by the following diagram;

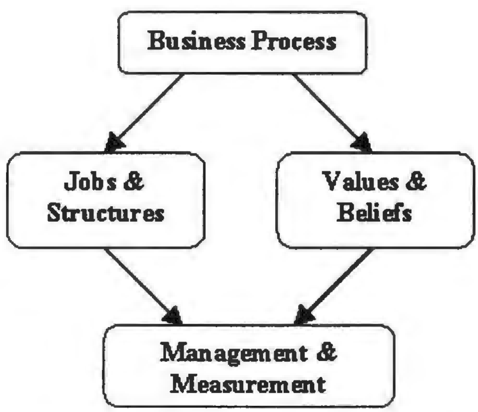

Figure 5: business system diamond

Such a reengineering process provides chances and opportunities to create those dedicated business processes that are suitable to be fulfilled by TWPs ideally and are in the interest of the company at the same time. The reengineering process also alters the management system, in particular the measures by which the performance of employees – teleworkers - is evaluated, which is necessary as soon TWPs do their job remotely and therefore are selforganised to some degree. If we put arguments together, we can conclude at this point: a radical redesign in terms of BR would be a in terms of structure and processes filtered out to be suitable for TW. But the success of Windows 3.x through an evolutionary approach teaches us to pursue a more evolutionary approach while having the overall target in mind. Each of the steps must establish a new TW-oriented process but must not ignore the implied structural changes and related side-effects.

Teleworking: a profession of its own?

In this section we come back to the remarks made in chapter 1.2. We reconsider the common view and statement that TW refers to "a method of working". Probably the following lines are controversial, because I state that TW tends to be a profession of its own demanding special skills, attitudes and therefore a specific curriculum too. Of course one must not ignore the application where a TWP is doing his or her task. The emphasis must lie in a combination of both: general knowledge in TW and special skills in the demanded application area.

Let me start reviewing what we mean and understand as the profession "programmer". We can classify this into application programmers, systems programmers or we could have a preference for a more general description e.g. "software engineer". We could even distinguish between a COBOL programmer and a C programmer and implicitly, because of the close connection between the programming language in use and its related application area, we would also emphasise a specialisation in an application field. However, any primary training in programming emphasises skills and experiences, which are common to all types of programming areas. The qualifications demanded are independent of the application area which programmers will be faced with later on. This in particular is the major didactical argument, that distinguished programming languages- most of them belong to the PASCAL family- are chosen as primary programming vehicles the despite legacy COBOL. C, C++ and JAVA are the programming languages of the "real world" today.

Considering management training programs we can make similar observations. Such programs address managers of all kinds independent from products and activities these mangers are involved. An educational program for managers contains (among others) subjects such as motivating people, self-organisation and making plans, budgeting, communication training and, of course, skills in common standard software.

If we transfer these observations to our particular concern, what are the skills and knowled which TWPs should be fully conversant, we can start a list of subjects without having any inta to propose a mature curriculum:

- experience in self-organisation
- project organisation
- mastering communication tools
- bookkeeping
- common standard software (whatever this might cover)

And this list has to be expanded, as soon we want to address people who want to start as employed teleworkers.

Imagine that you are an employer and a business process engineering procedure has filter tasks, which can be done better by TWPs. What would you be looking for; a person who acquainted with the particular area of application but needs a full training program in order master this by teleworking? Or, thinking of training costs, would you rather have a preference for experienced TW who is prepared to step into the specific field of the intended application? Fr your company's point of view in many cases it is easier or less expensive to train candidates in application field. There is a very appealing initiative in Europe, called "the European com driving license" ([ECDL97]). Currently this ECDL consists of the following basic modules:

1.Basic Concepts of Information Technology (Hard/Softwaresecurity&copyrightLAN/WAN, Email, Internet, workgroups)
2.Using a Computer and Managing Files (file-management, directories, printing, editor)
3.Word Processing (necessary basics of formatting text)
4.Spreadsheets (as above)
5.Databases/Filing Systems (creating datas and formulas)
6.Presentations and drawing
7.Information Network Services

and I suggest we expand this list of subjects towards skills, which are application independent essential for (the) future (of) teleworkers.

' A good question is how to instruct people in an 'application' field which currently is unknown or not ' Woped so far. In this particular situation we have to concentrate on general teleworking skills, spreading them as knowledge in a 'meta profession'.

It might be an academic discussion, whether TW is a profession of its own or if it is just a new way to perform tasks. But when we accept the necessity of additional skills and if it is clear, that TWPs have to perform well defined business processes autonomously as much as possible, then we have to train such people in dedicated skills and specific knowledge. Teleworking is much more than just allowing people to stay at home while doing a job.

Teleworking starts together with a business reengineering process and the processes filtered out are formed by persons who do not hesitate to work independently and are able to use modern munication tools and a set of standard software.

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The Impact of Telecommuting on Work Outcomes: An Examination to Job Satisfaction, Career Advancement Prospects and Turnover Intentions

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Magid Igbaria, Ph.D.

ABSTRACT

Due to the numerous demands from a variety of different constituents and advances in technology which can make remote work a reality, it is not surprising that telecommuting is growing rapidly. Yet, despite this growth, the research in this area is surprisingly limited. Given the continued growth of telecommuting, there is a need to fully understand the outcomes of this work arrangement. This research addresses this need by exploring whether work outcomes differ for professionals who telecommute and those who do not telecommute. This research considers a network of relationships concerning the impact of the work arrangement on work characteristics and experiences and the eventual effect on work outcomes.

1. INTRODUCTION

Telecommuting, a work arrangement that uses technology to bring work to people rather then having the people travel to work, has experienced a tremendous amount of growth and attention. Despite this growth, the research in this area is surprisingly limited. The literature that does exist is full of contradictions. A number of books and articles suggest that telecommuting will increase job satisfaction [5] and productivity [4], reduce employee stress [9] and contribute to a cleaner environment [13]. Conversely, other authors have insinuated that telecommuting has negative outcomes for employees, including loneliness and isolation [26], increased stress [30] and limited career advancement prospects [14]. Given the continued growth of telecommuting, there is a need to fully understand the effect of this work arrangement on work outcomes. This research explores how telecommuting impacts job satisfaction, career advancement prospects and turnover intentions.

2. PROPOSED MODEL

The proposed model is presented in Figure 1. The following sections discuss the proposed hypotheses.

2.1 Antecedents to Job Satisfaction

Autonomy is the degree to which a job provides freedom, independence and discretion in the completion of work [12]. Telecommuting is generally believed to increase autonomy by providing flexibility and control over when and where work is completed [8].

H1: Professionals who telecommute will experience more autonomy than professionals who choose not to telecommute.

Conceptually [20] and empirically [18] it has been shown that organizational conditions that respond to an individual's need for autonomy lead to positive outcomes, including job satisfaction, therefore

H2: Autonomy is positively related to job satisfaction.

Many believe that telecommuting will provide the flexibility to meet demands from both work and family [8]. Others have suggested that telecommuting will make it difficult to separate work and family, thus increasing conflict and stress [6]. These views are not necessarily contradictory. Researchers have proposed there are three dimensions of work-family conflict [10]. It is possible that telecommuting will impact these dimensions differently, thus decreasing some dimensions of work-family conflict and increasing others. Time-based conflict suggests that the demands of one role make it difficult to be either physically or mentally available to the other role [10]. It is this dimension of conflict that telecommuting helps to relieve. By giving the employee more control over when work is completed, the employee should be able to schedule work to minimize the conflict between work and family demands.

H3a: Professionals who telecommute will have lower time-based work-family conflict than professionals who choose not to telecommute.

Strain and behavior-based work-family conflict involves the ability to make adjustments between the work and family role. Commuting time may provide an employee with the time to adjust from one role to another [29]. Because telecommuters have eliminated their commutes, they are forced to change roles much faster, which may result in increased strain and behavior-based work-family conflict.

H3b: Professionals who telecommute will have higher strain-based work-family conflict than professionals who choose not to telecommute.

H3c: Professionals who telecommute will have higher behavior-based work-family conflict than professionals who choose not to telecommute.

Conflict between work and family demands cause negative outcomes. Work-family conflict has been found to be negatively related to job satisfaction [3].

H4: Work-family conflict is negatively related to job satisfaction.

Role ambiguity refers to an employee's confusion regarding what is expected by the employer [16]. Although many have speculated that telecommuters will not receive clear direction and feedback [23], the surveys of telecommuters have never identified role ambiguity or the lack of direction as a concern. The following hypothesis is proposed to test whether telecommuters experience less role ambiguity than non-telecommuters:

H5a: Professionals who telecommute will have less role ambiguity than professionals who choose not to telecommute.

Role conflict results when conflicting pressures occur so that compliance with one demand makes compliance with the other more difficult or impossible [16]. Shamir and Salomon [25] propose that role conflict will decline for telecommuters because they will have less informal communication which will reduce the chances of incompatible expectations. As was the case for role ambiguity, telecommuters have not identified role conflict as a problem. The following exploratory hypothesis is proposed to test whether physical isolation results in less role conflict:

H5b: Professionals who telecommute will have less role conflict than professionals who choose not to telecommute.

Role ambiguity and role conflict contribute to negative work outcomes. Research has found both role ambiguity and conflict to be negative antecedents to job satisfaction [22]. Thus,

H6: Role stressors will have a negative relationship with job satisfaction.

2.2 Antecedents to Career Advancement Prospects

The "out of sight, out of mind" adage is frequently used to argue that telecommuters will have fewer career advancement opportunities than non-telecommuters [2, 14]. Although there has been some limited support for telecommuting having no impact on career advancement [21], the majority of the studies [5] indicate that there is at the least the potential for telecommuting to negatively effect career advancement. The following exploratory hypothesis is offered to test this belief:

H7: Professionals who telecommute will have lower career advancement prospects than professionals who choose not to telecommute.

2.3 Antecedents to Turnover Intentions

Although authors and practitioners consider telecommuting to contribute to less turnover [23], empirical research has never addressed this issue. Research has confirmed a negative relationship between job satisfaction and turnover intentions [15], therefore, the following hypothesis is proposed:

H8: Job satisfaction will have a negative relationship with turnover intentions.

Employees are generally believed to be satisfied by career advancement prospects. Research has confirmed the negative relationship between career advancement prospects and turnover intentions [15]. Thus,

H9: Career advancement opportunities have a negative relationship with turnover intentions.

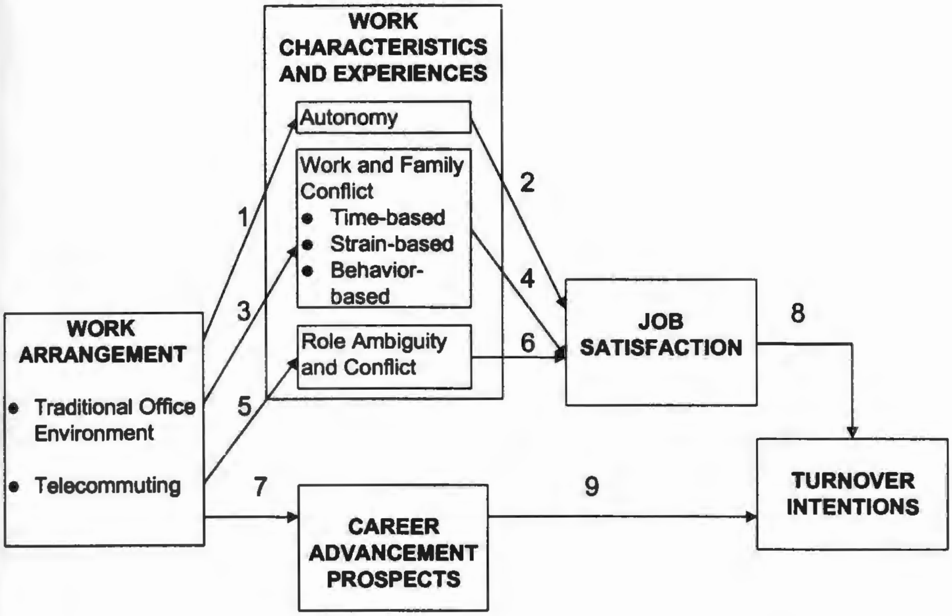

FIGURE 1 - Model of Proposed Relationships

3. METHODOLOGY

3.1 Sample

Data was collected from a large telecommunications firm which has been very active in establishing a telecommuting program. Each of the 225 identified telecommuters received a questionnaire. In addition to completing the questions, the telecommuter was asked to identify a non-telecommuting employee who most closely matches his or her present position and level. The identified non-telecommuters received a similar questionnaire. Useable response were received from 89 telecommuters (40% response rate) and 71 non-telecommuters (49% response rate). It was first necessary to determine whether there were significant differences in the demographic characteristics of telecommuters and non-telecommuters. A Chi-Square analysis revealed that data collection resulted in a sample of telecommuters and non-telecommuters from similar job types. Table 1 contains a comparison of the demographic characteristics of the telecommuters and non-telecommuters.

TABLE 1 - Comparison of the Demographic Characteristics of Telecommuters and Non-telecommuters

	Telecommuters (N=89)	Non-telecommuters (N=71)	t
Age	46.09	46.59	-.461
Organizational, tenure (years)	20.84	22.72	-1,659*
Job tenure (years)	6.40	6.71	-.316
Gender:			
Male	44 (49%)	48 (68%)	5.334**
Female	45 (51%)	23 (32%)	
Marital Status:			
Married	58 (65%)	57 (80%)	6.069**
Unmarried, living w/ partner	9 (10%)	7 (10%)	
Unmarried, not living w/ partner	22 (25%)	7 (10%)	

$p \leq .05$* $p \leq .01$** $p \leq .001$***

3.2 Measures

The multi-item measures are summarized in Table 2.

TABLE 2 - Summary of Multi-Item Measures

Measure	Cronbach's Alpha	Source
Autonomy (6 items)	.878	Hackman & Oldham, 1975; Greenhaus, Parasuraman, Granrose, Rabinowitz and Beutell, 1989
Job Satisfaction (3 items)	.798	Hackman & Oldham, 1975
Role Ambiguity (3 items)	.850	Rizzo, House & Lirtzman, 1970
Role Conflict (3 items)	.657	Rizzo et al., 1970
Behavior-Based WFC (5 items)	.820	Collins & Greenhaus, 1994; Wharton & Erickson, 1993; Allen, J.G. & Haccoun
Strain-Based WFC (8 items)	.833	Kopelman, Greenhaus & Connolly, 1983; Loerch, Russell and Rush, 1989; Wiley, 1987
Time-Based WFC (7 items)	.804	Kopelman, et al., 1983

3.3 Data Analysis

Hierarchical multiple regression was used to see if there is support for the proposed model. Gender, marital status, education, organizational tenure, age and job tenure were significantly correlated with the study variables and were therefore controlled for in the analyses.

4. RESULTS

Hypotheses 1, 3 and 5 predicted the impact of work arrangement on autonomy, work-family conflict and role stressors. The analyses revealed that work arrangement does not have a significant effect on autonomy, the three dimensions of work-family conflict, role ambiguity and role conflict. Additionally, work arrangement did not have a significant impact on career advancement prospects. Autonomy was not found to have a significant impact on job satisfaction. Time-based work-family conflict was found to have a significant negative effect on job satisfaction ($\beta = -.206$, $p \leq .05$). Hypothesis 6 was also partially supported. Role ambiguity was found to have a significant negative effect on job satisfaction (áV" = -.380, p ≤ .001). Hypotheses 8 and 9 propose that job satisfaction and career advancement prospects will, respectively, have a negative effect on turnover intentions. Both hypotheses were supported. Job satisfaction (ót/" = -.278, p ≤ .01) and career advancement prospects (ót/" = -.244, p ≤ .01) significantly impact turnover intentions.

5. DISCUSSION

Despite the widely held belief that telecommuting will contribute to more autonomy, higher job satisfaction and fewer chances for advancement, telecommuting was not found to have any effect on the studied work characteristics and experiences. Many of the results of this research contradict the conventional beliefs concerning telecommuting. Additional research is needed to expand the external validity of these findings.

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NO PLACE LIKE HOME - NO BOSS SMARTER THEN ME?

Dr. Peter Dobay

Abstract

Working at home, and/or working from home: a new challenge for managers being responsible for development, installation and optimal maintenance of computer assisted corporate information systems. Man-machine cooperation, social aspects, general and specific management problems (like cost-effectiveness, controlling, auditing, security) can not be handled by people coming directly from IT fields. Telework problems should be solved with information management tools. Actors of the Hungarian economy have radically changed in the last years: thousands of small businesses apply up-to-date information technology and large companies build inter-organizational networking information systems. Who will manage these interconnected complexes, what type of managerial knowledge will serve a fragmented organization with more and more knowledge workers working from home? The author suggests that a simple "The smartest boss is myself" attitude will not be a proper answer: telework can not be a simple self-managed work. .

Introduction

Today, telecomputing is revolutionizing a variety of fields, including education, banking, clerical and knowledge working from accounting to business consulting. Futurists agree that it will do more than the technologies together: the emerging info-communicative technologies and evolving philosophies about how people can share information will continue to create new ways to learn and conduct business in the coming century. Telework might be one framework for this brave new world: the era of "Go where the work is" can easily be changed for many of us to "Let the work go where you are". Among others, Spikes [16] gave statistical data about Britain: 1/8th of the companies had some "telecommuters", and he estimated the sum about 2.5 - 4.0 millions in 1995. Littlefield [13] presented a recent survey showing that 70% of large and medium-sized British businesses planned to introduce teleworking practices over the next few years. A US case [18] reported in 1995 that an AT&T branch in New Jersey turned 600 employees into telecommuters, and the company was able to save $6.3 million on a building lease - more and more shocking figures are emerging in business literature worldwide.[1]

The Business Week estimated the US teleworking community around 8.4 million in the US in June 1995 (see [1]), and said groupware, digital telephone lines, desktop-videoconferencing and wide-ranging cellular networks create a challenging office environment for all who understands benefit for employers and employees, too. The result: "It's no wonder the number of home-based telecommuters in the United States has risen by more than 30 percent since 1995 to 11.1 million in 1997," said Gail Martin, project director of Telecommute America[2]. Other sources say the US economy employs now around 10-15 million teleworkers, and there are researchers presenting double of these figures - the main problem is the definition, the lack of clear categories on telework jobs, teleworkers, distance workers, home workers, telecommuters, etc. As McClelland discuss cost/benefit issues in [3], due to teleworking, IBM France has been able to realistically predict annual savings of about $53 million in real estate costs alone by reducing the number of its sites in Paris from 18 to 6 in 1995.

In Hungary, Erdősi [12] estimated the strata only some thousand in 1992, and argued with a rapid development of the service sector, the changes in the structure of professions, and, of course, the ease availability of info-communication technology. As we experience now the recent rapid development of info-communication infrastructures, the problems of surface traffic and congestion periods in large cities, the absolutely "forgotten" mass of physically disabled, the teleworking framework should perform well in the Hungarian labor market in short time. The Bangemann-report of the EU DG XIII Committee put "Teleworking" on the top of a strategic list of 10 new elements of the Information Society - *managers* have to be prepared for a new paradigm.

In this article I concentrate on the *information management* aspects of teleworking, especially on the role of participants involved, and, of course, the challenges of leadership concerned.

Understanding terms

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[1] Employees in this case are working from home for half of each week and share office space the other half. Projected savings from the strategy total $8.24 million over 6 years, well over $13,000 per worker.

[2] An info from Telecommute America website, www.att.com/Telecommute_America/, October 20-23, 1997. (Telecommute America is a public-private effort launched in 1995 to promote awareness and understanding of telecommuting and telework arrangements. Founding members include TAG -- The International Telework Association the Association for Commuter Transportation, AT&T, the U.S. Department of Commerce, the U.S. Department of Transportation, the U.S. Environmental Protection Agency, the U.S. Department of Defense and the U.S. General Services Administration.)

Even in countries of being most ahead in teleworking, terms and definitions are widely used without clear understanding (see e.g. [8], [9], [12], [17], [19], etc.). From technological and managerial aspect, we feel the most important distinction the following:

Working *at a distance* (working *at home*): this should be an off-line performance with parameters being mainly similar of a traditional central workplace, but without being physically present there, without constant control and monitoring. Use of telecommunication (even temporary) is not a prerequisite. Managers keep contact using written documents, messages or by non-traditional communication systems: by phone, fax, maybe email.

Working *from a distance* (working *from home*): this can be either off-line or on-line performance but always with a possibility of an immediate connection to a remote machine capacity or telecommunication to/from a manager or co-workers at a distance. Here the on-line telecommunication - let it be continuous or only temporary - is essential to perform the tasks: in any time it should be available for completing the next subtask. Besides managers can at any time build a contact to a remote worker to monitor and control activities.

The words *telework* and *teleworker* are used widely for the second solution, the expresssions *telecommuting* and *telecommuter* are maybe more relevant for the first. One could say, these are not distinct categories: the confusing words are *the home* and *exceptional*. First, a distance workplace in many case is not a normal home, but a rent office space[3] near to the homes of the employees, a "neighborhood workplace", which in some case serves only some hours for that purpose. Second, communication actions can be very rare, exceptional, e.g. where the data can be collected physically only weekly, or following pre-defined trigger events.

Others simply say the word *telecommuter* can be used only for salaried employees: one of the quoted survey showed 48% of Americans involved identified themselves as "...a telecommuter (employee) who works at home during normal business hours", and only another 14% told they were "homebased business owners". It suggests that from the aspect of the business type we could simply tell that there are self-employed homebased businesses, which, of course normally need some back office activities, and, there are millions of distance workers who are on payroll lists as full time employees, being "sent home": they are the salaried "telecommuters".[4]

Making distinction between these categories can maybe easier if we take another parameter into consideration:

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[3] others use "satellite office", "telework office"
[4] Don't forget the impact of history, mainly in Britain: here the strongest argument has always been to cancel physical "commuting", the hours spent with travel from home to business and return.

- call a work *structured* where the tasks are performed in accordance with a strict schedule ("programmed") and follow algorithmic rules (that is; they "run" after a starting event);
- and call *non-structured* where only some sub-algorithms can help in solving problems, but mainly intuition and creativity eharacterizes the work.

Now using these categories it seems clear that many "structured" type work can be supplied even with low-skilled telecommuters, with exceptional or rare on-line *managerial monitoring* (necessary control can be achieved by a pre-written instruction set and regular checking of the output), while a non-structured problem is ideal for a creative knowledge-worker teleworker, for whom an unconditioned on-line access to databases, co-workers, experts or managers is essential in any time.

Transfer of structured tasks to homes seems now a traditional telecommuting solution, practically it started with the emerge of the first "portable" industrial standard PCs. Non-structured works march to private homes today with the rapidly increasing number of knowledge workers, and with the enhanced - and cheaper - availability of remote access to computer capacities and networking.[5]

Another aspect is the size of the business. *Large businesses* benefit from saving office maintenance costs, canceling office estates, increasing knowledge workers' productivity, enhancing consumer services with diversification, with demonstrating environment-friendliness, etc.[6] *Small businesses* are finding (see e.g. in [5]) that creating offices at home for themselves as well as for selected employees can increase productivity while improving their quality of life at little or no cost in the most sensitive developing phase of a company.

The widespreading telework literature works with more terms, some of these are now just listed without more specification below;

Office: The place, the venue of any knowledge-type work, an organization, which has functions to gather and create, to process and transfer data and information ([6], [9]).

IC workplace: Erdősi used that term in [12] to describe an office, where the job is related strongly to effective and integrated use of new info-communication technology.

Teleport: A (normally publicly accessible) workplace where consumers can have access to remote databases, Internet services, and in many cases professional advising and technical help.

Satellite office: The company simply "duplicates" the appropriate office space near to homes of the employees. The result is a remote office owned or hired by a single company, usually placed within a large concentration of employee residences, allowing employees to share common office space and reduce the time and expense of commuting to and from the main office facility.

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[5] Some examples: consulting, financial analysis, auditing, marketing research, information services, etc

[6] Like AT&T presenting decrease of thousand tons of carbonium dioxide "not-produced" by its managers

Telework center, tele-house, neighborhood-workcenter: A well-equipped IC office, and may or may not be a proprietary estate, with or without its own management and/or maintenance staff. The center provides workspace for employees of different companies in one location.[7]

Home office: The most popular form of telecommuting: the employee designates workspace at home to conduct business functions and agrees with employer to share costs.

Telecottage: A home with complete info-communication technology, ready for intensive, independent remote work. Some publications restrict this term only for top-managerial, executive workplaces, when high-level teleworkers perform decision making from their homes.

Remote customer-service center: A typical on-line workplace, which can add an extra level the usual telephone-based service (like telesales, teleservice, telemarketing): computer access.

Virtual or mobile offices: The last version in office transformation, when no physical site is needed.

As a summary, we can now create some categorization matrices for our responsible managers, (who normally look this endeavor aroimd telework suspiciously), giving some direct examples (Fig. 1).

Conflicts with traditional management

Management becomes to be a real problem for telework when the amount or relative importance of remote workers exceed a "critical mass", when the style of standard business processes shows a radical change. It means, in my opinion, a situation where the 10-15% of managers, or 15-25% of subordinates, or entire functional offices, or some critical processes are served remote, the business processes and management has to be ready for re-engineering.[8]

		type of job organization	
		working at home	*working from home*
legal status of the teleworker	*self-employed home business*	a writer a researcher a multimedia editor an architect	free-lance reporter design engineer any knowledge worker, like a programmer
	salaried teleworker	data input assistant info/processing data worker	telephone marketing network manager

[7] From cost-saving purposes this is the most popular solution in Hungary to establish telework environments. Small villages in under-developed areas can benefit of multiple use of a "telehouse" like that. (See at [31])

[8] A typical example: the AT&T adopted a corporate telework management policy in 1992 and now they live with 55% (36,000) of U.S.-based managers who telework.

		problem type	
		structured	*non - structured*
use of info-communication techniques	*constant on-line access*	telecommuter: teleservice, tele-sales, teleteaching, network-management	teleworker: remote management, teamwork - groupwork
	off-line workplace with only exceptional remote access	telecommuter: data input, subordinate design work	teleworker: author, designer, engineer, website manager

Figure 1.: Categorization of distance work

We all know that telework arrangement drops a huge rock to the calm water of traditional office management: as employees disappear former "manage by observation" methods do not apply any more. When the office arrangement tends towards teleworking, these conventionally working information processes simply collapse:

- Former solutions of information gathering and dissemination do not work any more
- The transparency of the corporate information system first decreases, till new methods of getting information about tasks, jobs, processes and employees can emerge.
- Project management technologies have to be changed
- Direct, face-to-face observing, controlling and leadership technologies lose ground
- Managers have to find new ideas to motivate office workers, etc.

As an immediate response, some managers simply say: "Telework is not for us". Using now some years of experiences worldwide we can make a possible list of basic challenges to management:

1/ Telework arrangement has to be planned, and installed properly

2/ New control and supervising technologies have to be developed

3/ Knowledge workers cause special human resource management problems

4/ Managers have to be "info-communication literate", using hi-tech equipments

5/ The entire project has to be more productive than the traditional arrangement

Entering into the details with all of these list elements we try building a managerial framework for managers planning and practicing telework systems:

ad 1/ Planning and installing telework arrangement

What makes the problem really serious; the traditional information architecture of the business has to be "splitted" somehow. We had functional offices, responsible managers, distributed databases, compact information processes and now the question arises: which part of this process (data, responsibility, etc.) should be dedicated to Mr. Tele-X or to Mrs. Tele-Y? The corporate information manager has to know the source, the value and cost of imported and indoor information, he should know the information needs of decision makers and standard process operators. Therefore he is the key figure to decide which knowledge processes can be transferred partially or as a whole to remote places. I feel it a brand new challenge: no doubt, former managers have to be trained for this type of workflow management[9] and teleworkers have to be trained - simply - to work alone.

Ad 2/New control and supervising technologies have to be developed

Managers have to substitute traditional controlling tools with new ones. Changing face-to-face interviews to email messaging, simple phonecalls to groupware scheduling, information dissemination meetings to webpages, problemsolving meetings to videoconferencing is not easy and need training and new skills from both parties. Known and accepted personal responsibility, plus well-designed corporate policy with experienced new professionals will make the system troubleproof.

Ad 3/Solving HRM problems of telecommuting

Participants of a telework arrangement are leaders, workflow managers, network managers, office workers and endusers. There are some new positions and professions - like network managers, telecommunication and security experts - but normally we have to work mainly with the traditional IT. Problems arise simply from the new environment: workflow control, motivating, compensating and special rewards have to be applied in a different way. We feel the most important to convince the teleworker that *he is not alone*, and to convince the manager that *he will have tools to continue managing* in a changed working environment.

Ad 4/Tele-managers have to be "info-communication literate"

Using info-communication technology affects telework environment in three aspects:

- Pure technology problems (communication, data transfer, safety, etc.)
- Semantical, cognitive problems (messaging, software use, etc.)
- Problems of effectiveness (instructing and controlling, self-motivation, etc.)

This is easy to accept that understanding *telecommunication* is the key issue in teleworking, even in case of rare connection. Coding and decoding both can be biased in this flow:

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[9] A simple example is an insurance brokering company, which works with visiting agents and cancels customer offices: reporting, data filing, claims, information retrieval, performance control should change radically

- The teleworker is not accessible: not being at home, having an unplugged equipment, or having a technical trouble
- A message sent can not access the recipient, or the message is biased
- The message is correct technologically but not understandable (from any reason)
- Foreign language document is received, or, an ineligible message is sent.

Beside telecommiunication and networking simple (electro-mechanical) office equipments or even viruses can cause troubles as well. I feel it a managerial problem: to avoid all of these troubles should not be a teleworker's responsibility. Appropriate technology, management of technical service, appropriate training, useful manuals, solving havaria-communication - these are challenges for a facility manager and the information manager as well.

ad 5/ Re-engineering has to serve better productivity

We believe that information efficiency stands on disciplined managerial environment. Managers have to state clearly *what* to send as a message, *to where, what extent, to whom, and when* in a telework arrangement - this is not a traditional office. The list below is a composition on different sources (see e.g. [2], [9], [13], [14], [15], [17]):

Usual benefits which build direct economic value: office costs can be reduced[10], non-productive time in offices decreases, more value-adding action can take place in work period, teleworkers work more productively[11], turnover time of tasks can be reduced if data transfer serves properly, overtime costs can be reduced, problems with tardiness or absenteeism disappear, customer service can be cheaper with direct "on the spot" response style, teleworkers can avoid the majority of direct and indirect costs of commuting, electronic communication is cheaper than paper.[12]

Usual drawbacks which cost more in economic value: different service and office supply team, other expertise, extra scheduling, enhanced time periods may cause more costs, many homes are simply not well equipped and built for telework; services around downtown office areas should suffer of decreasing demand, -surface-type postal services decrease.

Non-tangible benefits: Customer satisfaction with more business-related contact and enhanced services[13]; Just-in-time type services become available (telesales, telebanking, information retrieval, etc.): customers can have information in the form and time and mode they want; less inter-

[10] Best data can be found from the AT&T project: they report savings an average of $3,000 per teleworker annually in real estate and associated costs

[11] There are numerous surveys about this: an [AT&T] publication reports their managers work minimum 50 hours at home, and, of course, telework is ideal for output-oriented workaholics: there are no limits...

[12] Many books in office management (see e.g. [12]) quote the 80/80 law, which says 80 % of office documents are printed today in traditional offices and 80% of these will be keyed into another computer again.

[13] Different surveys estimate clerks can spend minimum 20% more time with customers

rupts makes processes more productive and smooth running; flexible workload and scheduling enhances quality of life for office workers; new type of labor becomes accessible for personnel managers; the technology gives a possibility to train the worker by teleteaching.

Non-tangible drawbacks: Not all tasks are best performed in a distributed, self managing "distance" environment; customers and partners have to be familiar with working style of our telework services; less motivated or young people can not work alone.

Only extreme businesses can turn 95% of labor to telework and cost structure differs significantly using a home office, a telecottage, a remote center or a virtual office.. Too often, when productivity or other problems appear, the result is a judgment that "telework doesn't work" or "telework doesn't work for us". The truth would better be to admit, "we made a mess of adopting telework"..

The Role of the CIO, a a special manager

A frequent question is in many case: who should lead this new type of re-designing project - the traditional office management, the telecommunication group, the HRM staff or the computer department, or any department can do what they want, starting with a telework environment? This questions again come close to the problem of today's managers: who would lead the IT-sensitive business areas? Can we follow Peter Drucker's maxim: "In the end, the only thing we have to manage is information itself"? To meet the challenges of the futxire, for many companies a *chief information officer* must lead the change what telework comes with.

Publications are doubtful about defining, who is that person? In some cases we can find description of a hybrid genius, being equally professional in IT, in networking, in management, in leadership, in finance, in quality management and, of course, in information management.

We feel the most important the last: the attitude towards corporate information management, the understanding of the value of the information asset and the role of information processes in corporate level, (see more in [4], [10] and [11]. Planning and installing a telework environment should be a part of an integrated corporate information strategic plan, where strategic, financial, managerial and even HRM approaches can prove the necessity or unusefulness of this organizational solution. Still the CIO, as originator of the strategic plan, can have a major impact in introducing the methods and technology: telework has been and will ever be an IT-addictive managerial tool.

How can a CIO, as a top manager, help a step ahead in this process? Let's enumerate some ways:

1/ *A CIO-driven strategic plan on information management* should make it clear, whether known and experienced ways of teleworking would fit long-term needs of the company or not.

2/ *Multi-party understanding should be achieved in what we want to do with teleworking.* The CIO is a person who serves as a mental bridge between the excited IT staff and traditional managers.

3/ *The information asset has to be protected.* Databases, standard operational processes, proved information flows serving customers, decision support systems all have to keep their integrity and level of productivity, managed by a CIO.

4/ *The CIO should understand new technology first.* This is not easy today to say NO for tempting hardware and software offers from vendors or the media. Questions are coming every day and the reason we pay high salaries to CIOs is to have lower possibility of failure in this field.

5/ *Managing IT-driven innovation needs a CIO.* Many innovative processes are affected by IT and/or IM methods and tools today. Therefore in many cases the CIO should lead the process for seeking possible fields of innovation and he has to define the role of IT in that process[14].

6/ *The CIO is the key figure when quality of information is issued.* Telework changes many parameters in getting information - all are quality parameters. Who should have access to what, when and how, for how much and why not if asked - the CIO should have appropriate response for these possible questions coming from the management or from customers and authorities.

7/ *If information is a key resource, crisis management is a core issue.* For information-sensitive businesses[15] (see in [10],[11]) a telework environment seems to be a dangerous experiment. The CIO should be the owner of crisis scenarios for remote teleworkers and for the central management and he should lead the IT/IM team when everything is in fire.[16]

8/ *A Telework Policy has to be established by top executives.* The CIO can be the proper person to formulate a corporate policy on telework, describing organizational solutions, necessary hardware and software environment, forms of work performance measurement, etc.

Summary

"Call Mondays, Wednesdays or Fridays in the office; Tuesdays and Thursdays at home." Does it hurt clients, partners or you, as a manager? *Managing in a distance working environment* is a real challenge - not an easy success. Tasks of the *remote supervisor* differ from those of a traditional office manager, even if telework policy dictates details of technology use and work performance

[14] Typical examples are telebanking or Internet-based electronic commerce (e-merce)

[15] Banks, international financial services, hi-tech industries, airlines, very large databases, etc.

[16] A successful example showed how can a well-designed information architecture protect a business from breakdown when a large Hungarian savings bank had to serve 20 times more excited customers as usual in a 3 days panic rush at ATMs in February, 1997.

requirements. Methods are all new, the technology has just arrived, experiences are different form our business environment needs - isn't it a real organizational change and challenge for management?[17] As direct and on-line observing has to be reduced, prevention should take more place in managers' toolkit.

There are many smaller problems, which have not been mentioned here. What should happen to some mid-managerial positions, how can we manage representatives of new professions, who would negotiate with the trade union, what would a new information architecture be like, do we need a CIO or will it be enough to hire an expert team for a while?

We all know, that if the technology is reliable, and legal problems are solved, the cost-sensitive SMEs should follow the big brothers very soon - it has happened many times in IT innovations on the same way.

Information technology builds no barriers on this way even in Hungary. But what I am convinced in, the organizational, managerial field will cause the majority of possible problems in a close future. The technology or even government support will be wasted and will end in pilot project level, if the management will not be convinced about the benefits of this framework, or, more dangerously, does not understand the words, the solutions, the role of this technology, and from this aspect say simply "No" for any proposal. Remember: something similar has happened to IT, to PCs, to networks in the last 15 years. Summarizing our managerial duties:

- Nobody is aware of the knowledge of Hungarian managers, what they think and know about teleworking. Duties are trivial.
- These managers have no real experiences with working cases, pilot projects: why should they be excited about?[18] The spontaneous way of development should be insufficient for Hungary.
- We probably need some *"Knowledge Centers"* serving regions to disseminate distance working information, to prepare necessary feasibility surveys, to organize trainings, to offer methods and tools to managers, employers and would-be telework employees.

And the latest advise to all managers, top executives, CIOs and outside experts: when everything is organized, designed, calculated, purchased, networked and formulated, please, ask the poor office [illegible] standing before the door of their former office, being now closed forever: "And... do you [illegible] want to work from home?"

If [illegible]ing, this can be a proper managerial support to success of telework.

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[18] [illegible] postgraduate students conducted a survey to 45 Hungarian SME managers: 40% told they use their PC at home - but only 15% guessed subordinates should do the same, as tele\workers.

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[18] A typical example: a Hungarian government project placed ads in January, 1998, into mass media like "Come on, register for home based telework, with government support". The result: thousands called every day, disabled, unemployed, being totally uninformed, and the answer is: "We look for businesses to employ you, first".

Rich Communication for International Cooperation

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Abstract

Dispersed organizations rely on distributed information processing, communication and collaboration. But this requires thoughtful information processing and rich communication, international cooperation introduces further idiosyncrasies in the development and product of information technology. This paper 1) analyzes the need for supporting cooperative work, particularly cooperative work that involves non-routine and non-structured communication in an international work environment; 2) proposes procedures for designing international telecooperation; and 3) determines some technical requirements of such systems. Although, our focus is international, we believe many of the ideas hold true for telecooperation in general.

1 INTRODUCTION

Learning and empowerment, often accompanied by dispersion, are characteristic of many of today's successful organizations. A learning organization relies on complex thinking and ongoing dialog [24]. Decentralized and dispersed organizations rely on distributed information processing, communication and cooperation [2]. But these require complex information processing and rich communication because today's diverse environments create a state of high uncertainty and high novelty that requires thoughtful rather than routine information processing and rich rather than lean communication [5]. For example, a structured report on daily sales is lean, while an analysis of trends and different explanations for the events that shaped the trends is rich.

Rich communication is needed not only because of higher complexity in the message communicated, but also because of the knowledge differences between the communicating parties. For example, communication between different organizational cultures, e.g., engineers versus managers, requires elaborate messages and descriptions of context [25]. International communication and cooperation introduce further idiosyncrasies in the development of information technology. Different cultures have different styles of management and different work practice [10].

Given the need for rich communication, it is disturbing to find very little guidance on how to provide it. This paper 1) analyzes the need for supporting cooperative work, particularly cooperative work that involves non-routine and non-structured communication, 2) proposes procedures for designing international cooperative systems, and 3) determines some technical requirements and mechanisms for implementing cooperative systems. We propose these issues as a possible approach for designing and building telecooperation and demonstrate some of the ideas in this paper with work on a recently established international MBA program.

2 COMMUNICATION IN LEARNING ORGANIZATIONS

A learning organization can be modeled as a system in which actors act on evolving knowledge. For example, Boland et. al [3] characterized knowledge as the collection of actors' interpretations of the relevant world and argued that communicating these interpretations will support actions. We expand this general direction here and use it as a model for analyzing collaborative work. Our characterization of a learning organization rests therefore on the following four elements:

1. Actors (decision makers, users, implementers).
2. Actions, including events not initiated by actors (the description includes action goals, procedures, rationale, and the action life cycle that describe actions in space and time).
3. Interpretations and data about actors, actions and their context.
4. A pattern of interaction among actors, emphasizing the communication of interpretations and data.

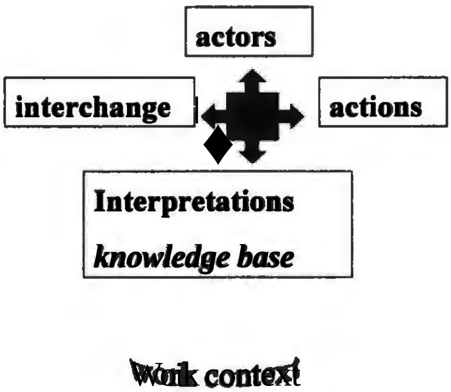


Figure 1: A framework for describing telecooperation

Figure 1 depicts these elements in the context of work. It serves as our framework for defining the design process of telecooperation later in the paper. Although we can use this characterization for a general analysis of collaborative work, the remainder of this paper concentrates on the analysis of communication in this context. Communication can be analyzed in terms of

1) its effect on specific actions and decisions, work and organizational learning,
2) its effect on the pattern of group interaction around actions, and
3) the accuracy and efficiency of the communicative act itself.

The Computer-Supported Cooperative Work (CSCW) literature deals usually with the first two aspects above. Hollingshead and McGrath [11], in a critical review of group support systems, provide several examples of such effects. At the level of work, communication affects I) the task product, e.g., time, number and quality of decision solutions, II) the users' reactions, e.g., satisfaction and rated effectiveness, and III) the relations between actors, e.g., attraction and feeling of alienation. At the level of pattern of interaction, communication affects I) the distribution of participation, and II) the amoimt of participation, e.g., total amoimt, amount on-task, amoimt inhibited and amount critical.

The communicative act itself is the most specific aspect. It can be evaluated in terms of 1) the product of communication in relation to its function, and 2) the receiver's understanding of the message in relation to the sender's intentions for the communication.

Poole and Hirokawa [22] identified several functions of communication in groups:

- Social information processing involves generation, analysis and combination of information and ideas.
- Analytic functions involve analysis of circumstances of choice making
- Procedural functions involve establishment of procedures for decision making
- Goal related functions involve establishment and monitoring of group goals
- Synergistic functions involve coordination and motivation of group members
- Rhetorical functions involve persuasion, social influence, leadership and visioning

Street and Cappella [32] add three more: Maintenance of coherence in discourse; Dominance and control; and Management of interpersonal intimacy.

For specific communicative acts, specific functions from the lists above can be defined, which become the basis for evaluating the communication act. For evaluating communication acts at the second level, i.e., the coherence of the communication, we used several theories of discourse comprehension to identify possible communication defectives. Habermas [9] claims that a communicative act assumes four conditions to be valid:

1) it is comprehensible so that the receiver can understand the sender,
2) it is true so that the receiver can share the sender's knowledge,
3) intentions are expressed truthfully so that the receiver can trust the sender, and
4) the commiunication is appropriate within some normative context so that the receiver can agree with the sender within this value system.

The section below discusses difficulties of communication that may bring about such breakdowns in communication.

3 DIFFICULTIES OF COMMUNICATION

3.1 THE NEED FOR AND DIFFICULTY OF RICH COMMUNICATION

Several influential streams of research posit that oversimplified information processing leads to declining performance and failure in modern organizations and policy making [12]. International organizations are no exception, and they are perhaps the most susceptible to simplistic perspectives that preclude other more appropriate perspectives of the reality in foreign countries [1

Rich Communication does not come easy because people tend to simplify and adopt only one perspective of reality, hold on to their own views, refusing opposite views, and tend to converge on a solution prematurely [12]. Like any communication that is not face to face, computer supported communication suffers from lack of verbal and non-verbal feedback, limitations of written language, limitations on form and other limitations of the particular technology used. These problems are magnified in the case of rich communications which itself is problematic and requires more diversity, richer and faster feedback, and rich descriptions of context.

3.2 DIFFICULTIES OF INTERNATIONAL, INTER-CULTURAL COMMUNICATION

Beyond the communication barriers that exist between any two people, communication across borders or cultures introduce additional difficulties. These difficulties can be grouped into three categories: content, language, and technical.

3.2.1 CONTENT

The first category is the content of the message and its context as the following examples from the international MBA illustrate.

1. An official and detailed description of costs and timetable were sent to a student from the Far East. From his response it became clear that he interpreted it as the opening offer in a bargaining process.
2. The local coordinator of the international MBA sent out a message to all international coordinators saying that book lists will be given to the students at the orientation immediately before studies begin. Despite this very clear message the American coordinator kept requesting a list of books for the students arriving from the USA because American students expect to have all syllabi and books weeks before classes begin.

These examples reflect how values and culture can influence communications - and similar cases abound. Kumar and Bjorn-Andersen [14] argue that information systems reflect the different value systems and biases of different cultures. Clearly, information systems that reflect inappropriate values will hinder or even distort communication. Sengupta et. Al. [30] used the term *view of work* to describe how work gets done in collaborative settings.

> *"A view of work constitutes knowledge and assumptions about people's individual and group activities, why they act in the manner they do, how they communicate and coordinate*

in performing their activities, and how they combine the functional and social aspects of their activities" ([30]., p. 245).

Tacit and informal mechanisms of work and communication (which are part of the view of work) enrich collaborative work [20]. In the international context, the diversity of views of work increases dramatically because of cultural differences.

3.2.2 LANGUAGE

Language refers to the symbolic and syntactic elements of messages that communicate the meaning. Limited language skills result primarily in misunderstanding but also in other negative consequences such as barriers to informal networking [16, 21]. The design of CSCW systems for international cooperation must consider the treatment of common knowledge and common vocabulary. A lack of common knowledge and vocabulary occurs when two or more participants have a different understanding of particular terminology. For example, in a financial environment, a currency trader based in Japan may interpret the sentence "There was a .5% fall in the dollar" to refer to a fall in the US dollar relative to the Japanese Yen. A Canadian trader, on the other hand, may interpret the same phrase as referring to a fall in the US dollar relative to the Canadian dollar. One US-based trader may share the meaning of the Japanese participant whereas a second US-based trader may share that of the Canadian trade. The use of international CSCW systems that require the exchange of electronic mail, spreadsheets, or schedules, needs to provide participants with a mechanism to resolve such terminology. Often, information must flow through intermediaries that may filter or even distort information to the extent that patterns of exchanging information is influenced by political considerations

3.2.3 TECHNICAL

Technical difficulties arise from physical distances, physical communication networks, computers, time differences etc. In managing the International MBA, the sheer 7 hours difference between central and peripheral offices not only slows down (asynchronous) communication but makes it harder to understand messages. For example, the fact that feedback can take at least 24 hours, during which new situations may arise, have caused several miscommunications between offices that have turned into personal frustration between workers. Students demand explanations from coordinator on certain guidelines and availability, but the coordinator has to wait for answers from load. Until those questions can be answered, conditions on availability have already changed. The coordinator and student become frustrated.

4 GENERAL DESIGN OF TELECOOPERATION

There are some general guidelines that should be followed in designing distributed systems to support rich communication that are discussed below. The general design principles revolve around two goals: rich communication and ease of use. Some of these principles were articulated in [3], but are reorganized and augmented here.

4.1.1 CREATING RICH COMMUNICATION.

1. Ownership. An interpretation is always owned by an actor, who is responsible for its creation and maintenance.
2. Context. An interpretation should include layers of context that explain why and how an action is performed.
3. Multiplicity. Multiple interpretations should be represented and available for critique by all actors engaged in the action.
4. Indeterminacy. Interpretations are not necessarily comprehensive, complete or precise so as to entertain tentativeness and equivocality in the system.
5. Emergence. Interpretations develop throughout the action life cycle and generate new interpretations which are usually more abstract and general perspectives representing a process of learning.

4.1.2 EASE OF USE.

1. Structure. An interpretation should be structured whenever possible.
2. Easy travel. Actors should be able to travel easily and intuitively from one interpretation to another and between layers of context or mixed forms within an interpretation.
3. Easy interchange. Interpretations should be interchanged easily by reducing difficulties of communication at the technical, language and content levels.
4. Interactivity. Interactive technology is not only a means for enriching communication but is also a means for ensuring easy travel and easy interchange. It is therefore highlighted as a design guideline.

5. Mixed form. Interpretations can be represented in different modes of expression. These range from text and graphs to pictures, sound and video.

The design goals outlined above are now brought to bear on the communications support system designed to help manage the International MBA program.

5 A SPECIFIC DESIGN OF THE INTERNATIONAL MBA PROGRAM

Earlier we mentioned a collaborative effort to introduce and manage an international MBA program. Below is a simplified analysis of the administrative work as a means of identifying areas in which we can enhance the richness of communication.

- *Situation and action*: the program seeks to recruit a class of students from around the world, perform administrative, academic and ex-curriculum activities, and generally provide the best possible learning environment throughout the studies. Most students join for a complete 14 month program. Visiting students, who are enrolled in other Universities, join for one or two modules either on an individual basis or as a group. More specific actions and their life cycles are detailed below.
- *Actors*: Among the many people involved in such a situation are the program director, program coordinators, American coordinators, and European coordinators. We ignore in this example many other collaborators such as the school director, various University functions, social guides, and employers for internship.
- *Materials and clients*: the clients are, of course, candidates who wish to study business and graduate. The materials include informational materials about the studies, tuition payments, housing, teaching facilities, etc.

Given a description of situation, actors and materials, we analyze the actors' individual information processing and only then examine the interchanges among them (the individual analysis is mentioned briefly for coherence as our focus is communication, see [15]). For example, the program director needs to schedule a repeat project presentation after the end of the semester for those who did not receive a passing grade. He has general information about the original course structure and other planned activities, from which he produces a first cut schedule.

6 DEVELOPING TELECOOPERATION

Applying the process described above to the needs of the International MBA CSCW system resulted in a number of concrete features and functions to support the CSCW activities. In this section we discuss how the CSCW design process is being used to augment a basic set of CSCW tools for use in an international setting.

6.1 ADDRESSING COMMUNICATIVE NEEDS

By implying the design process described above to the needs of the International MBA email communications, we have identified a number of concrete features and functions that can be added to an email application in support of the cooperative activities. In this section we discuss how the design goals presented earlier have been used in augmenting basic email to become a CSCW tool for use in an international setting.

The enhanced communications system, called HyperMáil, addresses a number of the design principles discussed above:

1. Ownership, through a mechanism for identifying and ascribing to shared semantics;
2. Context, through an automatic parse/link process that connects email terms to a corporate knowledge base;
3. Multiplicity, through the shared semantics mechanism;
4. Indeterminacy, by allowing dynamic modification of the corporate knowledge base through a process of organizational learning, and navigation through multiple interpretations;

In addition to addressing these design goals, the system also follows three ease of use guidelines through support of: Mixed form, Easy travel and interchange, and Interactivity.

In the following section, we present the HyperMail architecture, and explain how the system is used. This is followed by a discussion of how the functionality of the HyperMail system responds to both the design and ease of use goals.

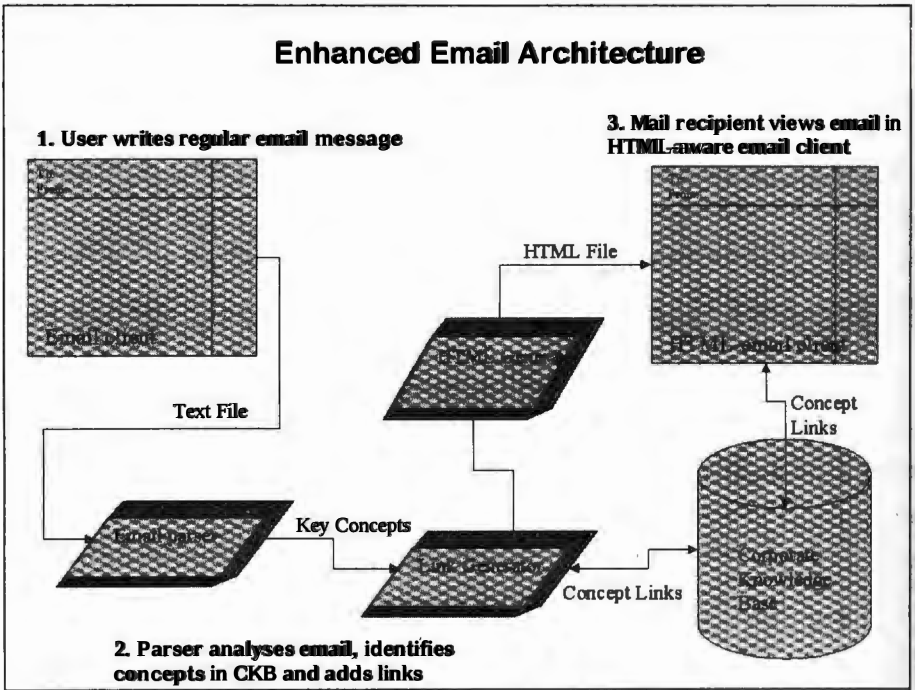
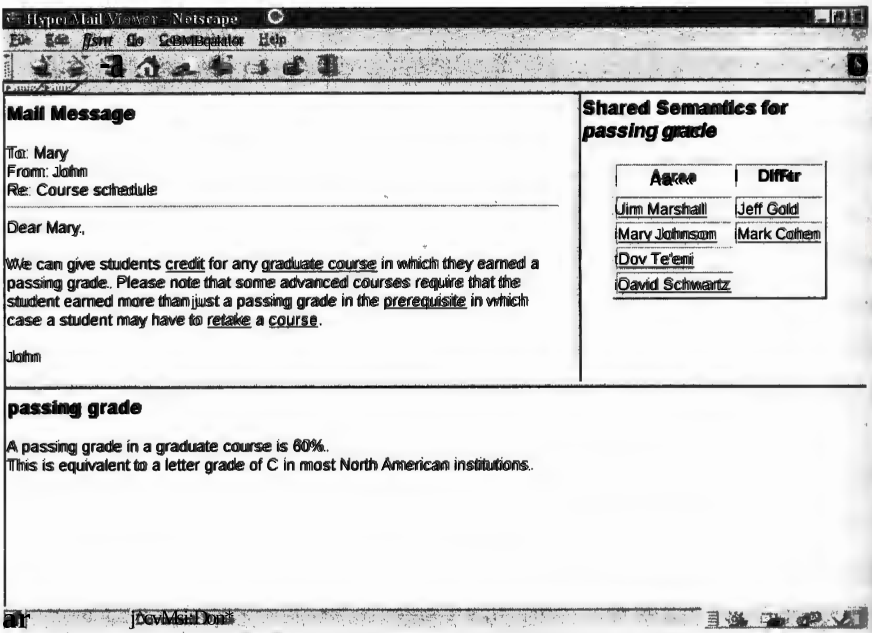


Figure 2: HyperMail Architecture

Figure 3: HyperMail Viewer



6.2 THE HYPERMAIL ARCHITECTURE

Figures 2 and 3 present an overview of the HyperMail architecture, and a sample sessi respectively. The system consists of an email client; a parser that analyses the email text, a sear engine that finds pages from the corporate knowledge base; and an HTML generat recomposes the email message with embedded links to the knowledge base. The recipient of an email message uses a standard Web browser to view and interact with the email message.

6.2.1 AUTHOR SCENARIO

Using a regular email client editor, John wants to send email to Mary. When John presses SEND, a dialog appears asking him if he wants to "Enhance" his email. The dialog presents three choices: Enhance and Send; Enhance and Preview; Just Send It. The process of enhancing the email parses the email text to identify any concepts located in the Corporate Knowledge Base (CKB). The identified text is augmented with a link to the appropriate spot in the CKB. An HTML version of the email message is created wherein the CKB concepts are presented as links.

6.2.2 RECIPIENT SCENARIO

Mary receives the email as an HTML file, and views it in a Web browser. Every key concept identified by HyperMail appears as a link in the email text. When Mary encounters a term in John's email that requires clarification, such as *passing grade*, she clicks on the link and views the appropriate page in the corporate knowledge base. Mary can simply read the email and ignore the links. The process of resolving links in the email does not simply bring up a static concept page from the corporate knowledge base, but rather an interface that combines the presentation of the email message, a window into the knowledge base, and a window showing shared semantic information. *Figure 3* shows the recipient interface. In addition to viewing concept information related to the email being read, Mary can choose to ascribe to a given meaning, disassociate herself from that explanation, or view the representations of other participants who do not ascribe to the given meaning.

HyperMail is a server-based email system that uses a web browser as its primary interface. Mail authoring, mail viewing, and knowledge base management are all handled through the same browser interface (*Figure 3*). The extent of capabilities supplied to a given user is determined by a user profile (i.e. not everyone can manipulate the knowledge base contents.)

7 DISCUSSION

7.1 OWNERSHIP, MULTIPLICITY AND EASY INTERCHANGE

The HyperMail systems addresses these three issues as one. In both administering and using such a system, there is interest in determining which participants ascribe to a particular interpretation. This is of particular importance in an environment supporting multiple semantic interpretations of the same term such as the financial trading environment described earlier. The International MBA case has the advantage of being a prescriptive environment in that the program administrator can determine what is to be the accepted meaning of specific terms. In a more dynamic peer-based system such as financial trading, the resolution of semantic conflict may involve some negotiation as to whose meaning will be accepted. Thus the tool can serve as a pluralistic or assimilative mechanism.

To facilitate such a process, a system must support multiple semantic meanings, and a mechanism to determine who ascribes to which interpretation. The upper right portion of the HyperMail interface presents information related to both ownership and multiplicity. In our example, each participant who has indicated agreement with the *passing grade* concept appears under the Agree list. Links are provided to an internal list of concept-meaning pairs that the system maintains for each user. By clicking on the name Jim Marshall, the information in the Shared Semantics window will be replaced with an alphabetical list of the concept-meaning pairs owned by Jim Marshall.

The names appearing in the Differ column are those participants who have indicated they do not agree with the given meaning of the concept *passing grade*. Clicking on one of those names, e.g. Mark Cohen, will bring up an alphabetical list of the concept-meaning pairs owned by Mark Cohen, but will also replace the meaning of *passing grade* in the lower window with the meaning ascribed to by Cohen. In this manner, the email recipient has access to multiple meanings.

7.2 CONTEXT AND MIXED FORM

HyperMail deals with the issue of context in a most straightforward manner. The context is essentially built around the corporate usage of a given term. Support for mixed forms is gained for free as the corporate knowledge base is HTML-based and can support graphics, audio, and video in addition to the text shown in the example herein.

7.3 INDETERMINACY

HyperMail's search engine dynamically ranks all concept pages related to a particular term. This ranking takes place using standard ranking techniques such as word proximity, number of appearances, etc. However it goes a step further by taking into account shared semantics information as well. Thus the ranked results of a concept search can change between each use of the system. We believe that this technique will prove particularly useful in consensus building across groups of decision makers in that it facilitates the dynamic convergence on an accepted meaning as more and more participants make use of a given term.

7.4 EASY TRAVEL AND INTERACTIVITY

A clear feature of the HyperMail system as shown in *Figure 3* is easy travel. In the body of the email text a number of phrases appear as hyperlinks. These hyperlinks indicate that the highlighted term is the subject of semantic interpretation. A hyperlink indicates that the term already has some shared semantic information attached to it. This mechanism also ensures a high level of interactivity as both the dynamically created links and the shared semantic information present the user with clear interactive features to enhance their understanding of an email message.

When the recipient of an email message clicks on the hyperlink *passing grade*, the shared semantics information relevant to *passing grade* appears in the upper right quadrant of the browser. The unobtrusive attachment of shared semantic information to the email message provides richness of communication in a focused manner. Recipients who are comfortable with the domain of discussion need not access the semantic information, whereas a recipient with potential cultural or conceptual differences can view the supplied semantic information. The shared semantic information for *passing grade* is shown in *Figure 3*.

8 CONCLUSIONS AND FUTURE RESEARCH

Adding support for viewing multiple semantic interpretations concurrently has been identified as a feature that the foreign coordinators could benefit from. The interaction between foreign coordinators and the central coordinator is not prescriptive in nature, thus there is ample need to resolve and reach consensus on the use of both content and language as we have presented.

We have argued that the needs of international CSCW systems differ to a certain degree from th of classic CSCW. The design factors we have proposed for International CSCW systems takes i account the principles of designing distributed systems. By providing actors with the sh semantic information mechanism, the system design embodies the major principles for desig distributed telecooperation systems: Ownership; Easy travel and interchange; Indeterminacy a Multiplicity.

Ownership is established by an actor creating a new semantic interpretation or associating him with an existing interpretation. Easy travel is implemented through the hyperlink mech Indeterminacy is supported through the dynamic nature of link creation and ranking mechani the search engine. Multiplicity and easy interchange come into play through the support of mu semantic interpretations for different actors. Having HyperMail address these five major de principles, adds levels of richness to otherwise flat email communications furthering t effectiveness of telecooperation in international groups.

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IT CRITICAL SUCCESS FACTORS FOR GLOBAL ORGANISATIONS

V. K. Khandelwal[1] & J. R. Ferguson[2]

Abstract
This paper examines the Critical Success Factors (CSFs) for IT management across four geographic regions. It examines the CSFs as measures for IT maturity using Nolan's Stages of Growth by drawing upon, and extending previous research [6]. Clear differences in IT maturity are shown. For global IT management, differences in IT maturity should be considered when developing global IT strategic plans.

1. Introduction

The task of managing IT is becoming increasingly complex. At one time the IT manager's responsibility was limited to the provision of technology support and solutions to an enterprise in a centrally controlled local environment. Globalisation of business has made this task manifold more challenging. Recent years have witnessed phenomenal, albeit disproportionate growth in the use of IT around the world. This has resulted in different geographic regions attaining varying levels of IT competencies and maturity [6]. In such a complex environment the IT manager of a global organisation is not only required to align IS products and processes to the global objectives of the enterprise, but also interpret technology trends and policies in different geographic regions, recognise their differences, select technologies that provide most value to the enterprise, and help the enterprise constantly modify its business strategy to stay competitive. An imperative for a successful IT manager in a global organisation is to understand differences in IT issues in various geographic regions, and manage them effectively.

The purpose of this study is to determine the levels of IT maturity and competencies in different geographic regions, and evaluate their differences. For global organisations this will help their management in determining their IT strategic plans and priorities in the geographic regions in which they operate, or wish to operate, and in developing a level of confidence in their IT investments. The findings of the study will help governments in different geographic regions

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determine their national strategies for harnessing information technology effectively. And finally the results of the study will guide the academic institutions to streamline their curricula and research projects so that they are aligned to the global market forces.

2 Methodology

For a study of the pattern of IT maturity Nolan's Stages Theory is probably the most well known and widespread framework of the development of IT in organisations [10, 11, 12]. The theory provides an insight in the way IT evolves, and offers the IT management the possibility of managing this complex phenomenon.

Nolan's stages theory identifies three eras, data processing (DP), information technology (IT), and the network (NW) era, that an organisation will pass through in its information technology growth. These eras are themselves subdivided into three stages each (Initiation, Contagion, and Control stages for DP era; Integration, Architecture, and Demassing stages for IT era, and Functional infrastructure, Tailored growth and Rapid reaction for the NW era) as they undergo their S-, or growth curve (Figure 1). The curve represents both the growth of the information technology and the organisation's learning experience as it progresses through these eras.

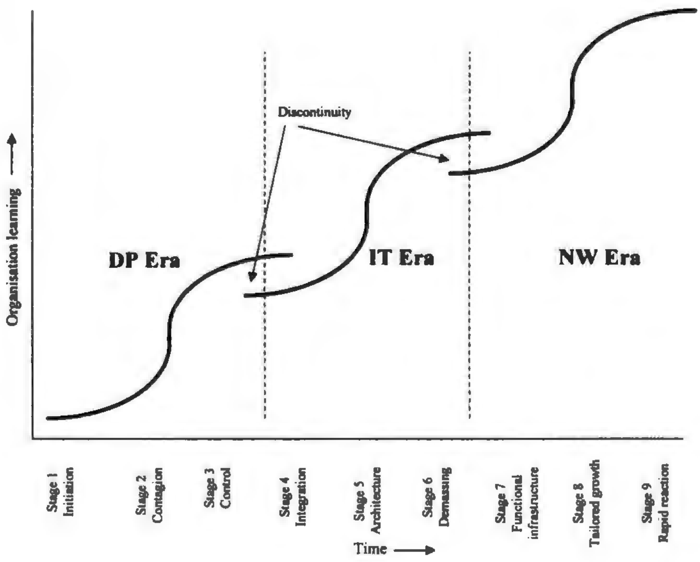

Figure 1. The Nolan's Stages Theory

Each stage is characterised by business, management and IT issues as described in Table 1.

Era		Stage	Key characteristics
DP	1.	Initiation	Operational support, largely finance and accounting
	2.	Contagion	Rapid expansion. Little control. IT expenditure growing 20% to 40%
	3.	Control	Control of high automation cost. DP steering committee. Use of methods/standards
IT	4.	Integration	Integration of applications. IT enables new business methods. Systems justified for business contribution
	5.	Architecture	Information dispersed. Data management is critical. New systems focus on strategic business objectives
	6.	Demassing	Business unit has responsibility for deployment of IT. Disbanding of centr IT.
NW	7.	Functional infrastructure	Translation of business architecture into a new additional layer of functio infrastructure. User community capable of developing new applications usi the common corporate infrastructure.
	8.	Tailored growth	Expansion of the functional support for users by adding top layer applic that use the functionality provided by the functional infrastructure.
	9.	Rapid reaction	Adaptation of functionality with dynamic business team changes. Many required adaptations performed by the users by simply changing the parameters.

Table 1. Characteristics of Nolan's Stages of Growth

To analyse the stages of growth pertaining to the different geographic regions use was made of the IT Critical Success Factors (CSFs) for the geographic regions. The effectiveness of the CSF approach as one of the most effective tools for management decision making is well established [13]. Critical success factors are those few things that must go well to ensure success for a mana [5]. For the purpose of this study a number of sources have been used to identify the CSFs for different geographic regions. The Australian CSFs are based on a survey of 408 organisations covering the top 1000 private sector, and 1000 largest public sector organisations in Australia [7]. The CSFs of North America and Europe are based on the investigation carried out by CSC involving 339 and 120 corporations in the North America and Europe respectively [3]. The resu of India are based on an investigation of large firms in various regions of India covering 69 enterprises [8].

The respondents covered various industries, such as, finance, insurance, mining, government, health, legal, manufacturing, production, retail, consumer goods, energy, utilities, software and services.

3. Critical Success Factor analysis

Based on the analysis of the above data the most important CSFs for each geographic region were determined. These were termed as the key CSFs. Table 2 lists the key CSFs across various geographic regions in order of their importance.

Key CSFs- North America	Key CSFs- Europe
1. Alignment of IS and organisational objectives	1. Alignment of IS and organisational objectives
2. Data availability to users	2. Instituting cross functional systems
3. Use of emerging technologies	3. Data availability to users
4. IT for competitive or significant advantage	4. Cutting IS costs
5. Linking with external organisations	5. Linking with external organisations
6. Integrating systems	6. Strategic IT plan development
7. Management of IS human resource	7. Reengineering of business processes
8. Strategic IT plan development	8. IT for competitive or significant advantage

Key CSFs- Australia	Key CSFs- India
1. Alignment of IS and organisational objectives	1. End user service management
2. Strategic IT plan development	2. Alignment of IS and organisational objectives
3. Data availability to users	3. Technical skills of IS staff
4. End user service management	4. Strategic IT plan development
5. IS-user partnership	5. Management of IS human resource
6. Disaster recovery planning	6. IT for competitive or significant advantage
7. Educating senior management in IT	7. Quality of systems development
8. Network security	8. Project management methodologies

Table 2. Key CSFs in various geographic regions

It was found that some key CSFs were common to all geographic regions. Also there were certain CSFs that were considered of less importance in all the geographic regions. Finally some CSFs had mixed reaction among the geographic regions, with some IT managers considering them more important than the others. These results are discussed below.

3.1 Key CSFs common to all geographic regions

From the above discussion it is clear that the following two CSF themes are considered most important by all the geographic regions under consideration.

1. IS-business alignment, which includes alignment of IS and organisational objectives, and strategic IT planning

2. End user fulfilment, which includes end user service management, and data availability to end users

While in most cases the IS alignment is yet to be achieved, in some instances it may have been highlighted as a top issue because of it being an annual rolling plan process. Also there is an extremely high level of concern on fulfilling end user information requirements.

3.2. Less important CSFs in all geographic regions

Following are the CSFs that were considered less important by IT management in all the geographic regions under investigation.

1. Outsourcing IS
2. Decision support systems implementation
3. Reviewing IT organisation
4. Assessment of business value of IT

3.3. CSFs with mixed reaction among geographic regions

The following CSFs had mixed reaction among the above geographic regions, with some of the IT managers considering them important while others considering them less relevant.

1. Reengineering of business processes
2. Use of emerging technologies
3. Disaster recovery planning
4. Management of IS human resource

4. CSFs and stages of growth

There may be some question over the use of CSFs, that were designed to measure an organisation's position in IT relative to current concerns, to be instead applied to a maturity model, albeit Nolan's, for establishing the present position of information technology, and to make predictions of the likely directions and strategies that can be expected in the future. If respondents are concerned about accurate, overnight processing of the order-entry application we can reasonably conclude that they may not yet be concerned with electronic security on the web, but in time they will.

Establishing the present stage of development permits comparison with the wider community, and considerations of future directions.

Stage 3 CSFs	Stage 4 CSFs	Stage 5 CSFs
1. Strategic IT plan development	1. Reviewing IT organisation	1. Linking with external organisations
2. Organisational standards for IT	2. Information architecture development	2. Reengineering of business processes
3. Quality of systems development	3. Adoption of open systems platform	3. Distributed systems
4. Project management methodologies	4. Running IS as independent business	4. Workflow and work management implementation
5. Reduction of software maintenance	5. Software development productivity	5. Multimedia implementation
6. Alignment of IS and organisational objectives	6. Assessment of business value of IT	6. Office systems implementation
7. Disaster recovery planning	7. IT for competitive or significant advantage	7. Image technology based applications
8. Network security	8. IT for competitive or necessary response	8. Use of emerging technologies
9. Security of IS facilities	9. Data availability to users	
10. Business skills of IS staff	10. Educating senior management in IT	
11. Industry skills of IS staff	11. Decision support systems implementation	
12. End user service management		
13. IS-user partnership		
14. Educating end users in IS tools		
15. Technical skills of IS staff		

Table 3. Mapping of CSFs and the stages of growth

We debated the method of mapping CSFs to the Nolan growth stages. Rather than apply a literal interpretation of Nolan's narrative descriptions of each of the growth stages, we applied the intention of the growth stage itself. Also, some CSFs could overlap multiple stages. However agreement was reached on "the best fit" of a CSF to a growth stage. The result has been that each CSF is mapped to a growth stage that best satisfied the intention, rather than matching on particular words and phrases, between the two. For example, "Assessment of business value of IT" could be mapped into either the "Control" or "Integration" stage, but was allocated to the "Integration" stage as it pertains to delivering business value to the enterprise through integrated systems, rather than through cost control. Three CSFs, including, "Management of IS human resource" were not allocated any stage on the growth curve as we considered they are not linked to the growth process.

The result of this mapping is shown in Table 3, from which it is evident that the CSFs under consideration only pertain to stages 3 to 5 of Nolan's stages theory.

5. IT Maturity in various geographic regions

As mentioned earlier to investigate the maturity of IT in various geographic regions all the CSF data was mapped onto the appropriate stages of the growth curve as above, and analysed.

For each geographic region mapping of the top 19 CSFs showed an almost continuous trend from stage 3 to stage 5 with decreasing criticality of the issues as is evident from the trendlines for various geographic regions shown in Figure 2.

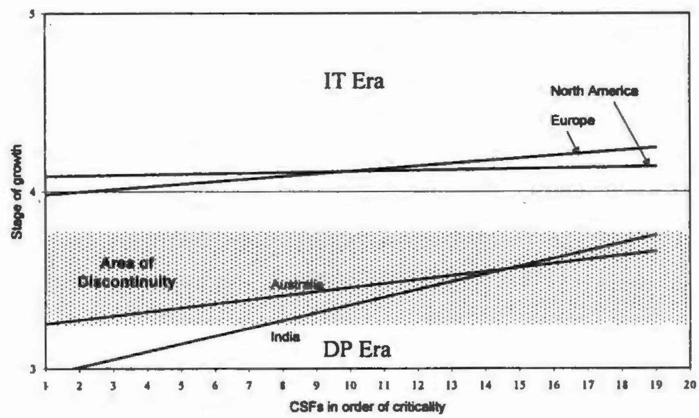

Figure 2. IT maturity trendlines for different geographic regions

Although there are minor differences between North America and Europe, it is clear that both the geographic regions have successfully overcome the discontinuity of stages 3 – 4 (DP era – IT era) and have stabilised in the IT era of maturity. It would seem that they are also on their way to higher stages of growth.

Australian organisations are in the midst of overcoming this discontinuity before they can progress and become stabilised in the IT era. Earlier study [6] has shown that this situation has not changed much for the Australian geographic region for at least past five years. Obviously the organisations in this geographic region have to take some radical measures to rectify the situation.

Indian companies are in stages 3 – 4 and are struggling to successfully cope with this discontinuous growth. It has been concluded [8] that among other things the line of business and IT management of these companies needs to work together to develop strategic IT plans before these companies can mature further and overcome the discontinuity.

None of the geographic regions studied have reached the network era. To do that would involve the challenging task of overcoming the discontinuity between the IT era and the NW era.

From the above discussion it is evident that there are marked differences between the IT maturity in different geographic regions. When an organisation is developing IT systems across geographic regions it is necessary that these differences are recognised. A strategy that may be appropriate in one geographic region may be quite inappropriate in another. We can suggest a simple scenario as illustration. Suppose a global organisation has its head quarters in a more mature geographic region, say North America, and a second location in a less mature geographic region, such as India or Australia, and is implementing an IT system across these geographic regions. We suggest that it would be wrong to assume that strategies applicable in the North American location are appropriate in India or Australia. Responsible management should recognise this, and employ strategies that are relevant to the maturity of each organisational entity. Although this appears to be self evident, we have found that the senior IT management of global organisations overlook this vital consideration (Interviews conducted for [4]).

Differences across geographic regions are also illustrated by the CSFs with mixed reaction among geographic regions (refer 3.3 and Table 2). As an example, in North America we see *use of emerging technologies* high in the CSF list, whilst in India we see *technical skills of IS staff* in a similar position. These CSFs exemplify the geographical maturity difference. Deployment of an IT system across the geographic regions may require significantly differing strategies for the implementation and support of the technology being employed in the system.

For the management of a global organisation it is essential to understand these differences so that information systems may be implemented appropriately and competencies available in the geographic regions in which the systems operate may be optimised.

6 Conclusion

Organisations are globalising. Among the important factors for effective globalisation is the effective use of information systems [9]. Examination of Critical Success Factors (CSFs) for IT management across four geographic regions and the mapping of these CSFs against Nolan's Sta of Growth shows that the geographic regions are at varying levels of IT maturity. When inform systems are developed to support the organisation across geographic regions, IT management should consider differences in maturity when determining the global IT strategic plans and priorities. We suggest that CSFs provide a measure of maturity, and are a useful tool for management in the effective use of information systems in global organisations.

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The Business Strategy towards the Global Information Society - The Results and Conclusions of a Survey in Hungary -

Maria Raffai dr.

Abstract

By the end of the 20th Century the information has become more and more the main resource and motivating power of the society and the business life. In this situation the firms are not able to improve a dynamic development and to execute the continuous economic activity unless they take into consideration the national and the international business conditions and the trends of evolution.

As in the last few years the society of the central and eastern European countries have changed to a new political form it would be particularly important for them to take part in the world-wide development of the new technology process. That means for businesses (small and medium-sized enterprises) that they have to invest into the building information technology infrastructure in order to ensure economic convergence between the eastern and western Europe.

In this new situation the society and the business life needs experts with new knowledge: economists, engineers, specialists in computer science and information technologies who are prepared for the computer aided decision making, controlling and the effective communication and co-operative work through the computer network. In the year 1997 I performed a survey among the managers of 865 different kinds of enterprises in order to learn

- *what is the new role and the importance of the information,*
- *how do the managers think about the new resource: the information*
- *how is it possible and what does it cost to get the up-to-date information about the business life and the competitive partners,*
- *what kind of tools and technologies are available for the teleco-operation,*
- *how is it planned to develop the technological infrastructure,*
- *what kind of computer-net services are required to use,*
- *what kind of co-operation-system will be developed*
- *what kind of added knowledge is to be expected from the manpower, and how will they skilled for the new tasks and so on.*

In my presentation I am going to speak about the results of this statistical analysis, and I will show some statistical tables and graphs which give a general appearance about the business life, about the mission and vision of the Hungarian enterprises and the ideas of their managers, shows the ability confirming to the new conditions, represents the requirements, tasks and responsibility of the society in this new era. Finally I should like to present a new, for the Hungarian business environment adapted BPR methodology, the **RTεBP** *method, which was developed by myself in the frame of my Ph.D. dissertation.*

1. The Challenge of the Information Society

Nowadays there are two kinds of revolution in progress with very strong contact to each other, on one side there is *the digital revolution* with the always renewing technologies, and on the other side there is the process of *the globalization* concerning the production and market. This situation ma not only the information universal but the knowledge as well. The current, exponential growth of the information requirements, the information explosion, the growing importance of the up-to-date in formation, the globalization process of the knowledge results a never experimented develop spiral.

A new social-economic structure is getting to be formed, and it is definitely different from all k of other earlier society systems. In this new era based on the results of the Information Technol (IT) and the Telecommimication (TC) we can see great changes: (1) the border between countrie disappearing, (2) the real-time communication becomes realty all over the world, (3) our comm tions, habits and behaviour changes our life. We can be sure, that these attributes are going to be strongest factor of the societies in the next century. In the Information Society the achievement the IT and the telecommunication play a special and definite role. By the computer networks it possible for more and more people (1) to get in contact with the other human being all over world without any kind of time or geographic limitation and (2) to reach the necessary up-to-d information in advance for the business and the private life [11].

The information in this new type of society is a very important resource, strategic and compe factor. It has a key-role in the business life, in the production and administration work, it is the k component of the scientific research. We can say that by its influence on the society and the econo the information is the engine of the economic growth [10].

The economy and the society is getting to be changed from the roots. The managing of the informa tion system plays the most significant role not only in the procedures of planning, execution and ising the production or service procedures but it will be very useful also in our private life. We ca arrange our tasks much more effective and on higher level. What are the benefits of this new type of society? Let's see them briefly:

- the products and the services will be global all over the world,
- the distributed organisations located on different geographical territories are able to work ef fectively together,
- the administration in the government and civil service will be a key factor: "one stop-An stop" services will be organised,
- the response time at all the activities are getting shorter and shorter,
- the life cycle of the product and the procedures become shorter,
- the computing and information technology will be in general use.

For the above mentioned reasons the computing, the *IT* and *TC* speed up *as a catalyst* of the soci economic procedures by the end of the 20th Century. The statistics on creating, increasing, mainta ing, queering and using databases show dynamic progress, the trends for the application of the on-li services suggest continuous evolution. For example in the last 15 years the number of created da bases has grown 18 times more, the ratio in the GDP for the product of IT and TC branch of the developed countries has reached over 50%. The experts say that the first decades of the 21st Ce tury will be determined by the IT and all of the activities and innovations will focus on the realisati of the information society [1], [2]. The most progressive sector in this new era will be the *informa tion service*.

In this competition we have to pay stronger attention then earlier to the parameters which describe the development, point at the expectations and the tendency. Figure 1. shows the growth of the IT sales in the world market [12].

Figure 1.

	Income in mrd USD			
IT and TC Market	1997	1998	1999	2000
hardware sale	44,0	51,9	61,5	72,2
software engineering	98,2	107,2	118,3	128,3
operation systems	56,2	60,9	66,9	72,9
system integration	32,0	36,5	41,8	47,5
application systems	53,3	57,2	61,9	66,2
network services	40,7	47,7	56,6	67,0
user services	73,2	83,2	96,7	111,1
ready to use systems	42,0	45,6	49,6	53,6

Source: Input

Some numbers showing tendencies:

- 10 million of computer on the Internet in 1995,
- information from 5,5 million of databases in 1995,
- by 1999 the prognosed number of Internet user should be 200 million,
- in the last 3 years the number of the Internet connections in Hungary has became ten times more than earlier

The realisation of the information society is a great challenge for the governments, the business life and especially for the management, because they are in the key position in this evolution process and they are responsible for providing the circumstances and the conditions. They have to intervene in the development process by encouraging the competition in the market, and by stimulating the application of the new technologies. The efforts for a reorganised and reconstructed information infrastructure can result new workplaces, and so it can cause the prosperity of the societies and the humanity. Europe and of course our country, Hungary have also their own tasks [6], [7]:

- we have to strengthen the competition which leads to the reduction of the TC costs,
- it is necessary to change the labour-law in order to fit to the flexible working methods,
- it is important to enlarge the groups of persons, who can access to the new technology-possibilities,
- it is expected the security and the safety of data and processes, to grant the protection of the privacy.

By the end of the recession the European Union has a great responsibility to get Europe afloat on the right way in development, and to work something off the drawback to USA and Japan. Europe needs new political concept against the protectionism, the work-time reduction, the total economic liberalism to solve their social-economic problems. It is necessary to emphasise the importance of the efforts for increasing the competitiveness from horizontal point of view [12].

The earlier intention of the developing countries for the new social-economic form as the *"Information Super Highway"* program (USA 1993) and the *Info-Communication program* (Japan 1994) stimulated the management of EU to describe the characteristics of the information society and define the aims and tasks for the realisation [1].

In the today's Hungarian situation we have to take into consideration the international efforts for building a modern information infrastructure, and we have to plan the right strategy as a reaction for the great challenge. This is the only possibility to get closer to the developed countries, and to join the economic circulation of the world-society. But this means serious work for us, because we need to make decisions with taking into consideration the interest of the domestic business life and culture. *The National Information Strategy* (NIS) and *the National Information Infrastructure Development Program* (NIIF) is to specify these aims and the tasks of realisation.

2. The Information Resource as Strategic Factor

For today the information has become the key factor in executing the tasks of the business life, such as making decisions, controlling and füilfilling the production procedures. Gathering, converting, storing, processing and taking care of the information systematically these are the competitive components which influence the business success. It is important though, that the information has to gain its importance similarly to the other production factors, and it needs to be the organic part of the economic activity. The information management systems have of course special characteristics, but they are functioning by the same rules as the other social-economic systems. Let us see some specialities:

- the information system influences the success or unsuccess of the organisational operating,
- the tasks and the realisation of the information strategy is an important competitive factor,
- there is a strong interaction between the market and the information infrastructure etc.

We can definitely say, that the information system is one of the most important tool for achieving the purposes. To this work the organisation has to possess the appropriate management being available on all hierarchy and subsystem level (See Figure 2.).

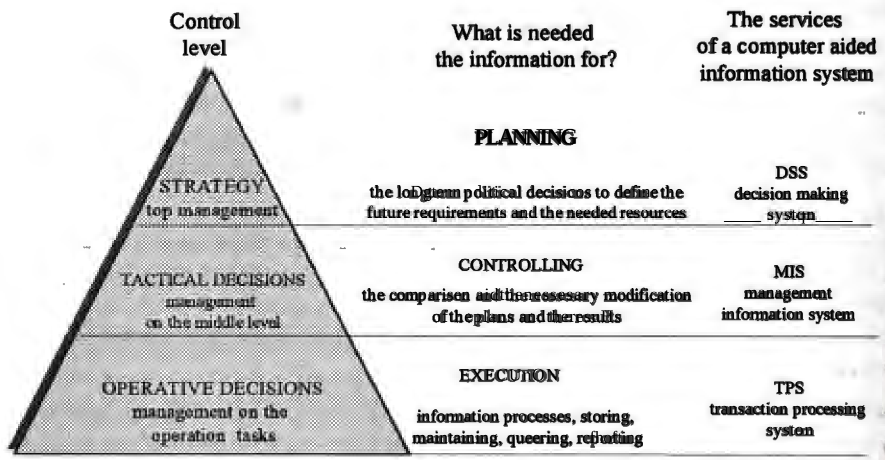


Figure 2. The modules and services of a computer aided information system

The strategic management of the enterprises focuses to get *competitive advantages*. For the computer based decision making activity the managers use efficient methods, tools and technologies, by which they can provide an optimal process for the organisation. But for operating an effective information system and relevant information the leaders and especially the top management has to understand the importance of *the value chain* of their own business activity [8] with the components:

- getting and using the information similarly to the other resources,
- execution of business processes which realises the strategic goals,
- other components, as the channels for product distribution, marketing segments, supplies, customers etc.

and they make the decisions in contact with the definition of the business strategy in aware of this knowledge.

It is very important to utilise all the benefits by the help of *the value chain analysis* which is strategically applied by the possibilities of the computing, information technology and computer networks. With this activity during the decision making and the development work the businesses are forced to concentrate to the units which measurably makes the global achievement of the hole enterprise better [10]. But we have to declare, that in this new social situation the high-tech possibilities can only help the business efforts, when (1) the managers see some good, effective practices from the other ventures, (2) they possess government subsidies and (3) they are committed in the successful application. The collaboration of the governments and the enterprises, a co-operation with the high-tech enterprises similarly to the industrial model of the Silicon Valley [13] is basically important to create the up to date electronic infrastructure and to stimulate their application [2]. The result of the innovation processes is a new resource by which all the enlarged requirements are satisfying, and which becomes an efficient tool for the managers.

But we could see substantial changes in forming opinion of *the significance of the information* only from the middle of nineties, when the Internet network has become world-wide accessible. A real explosion in the business applications can only be proved by the appearance of the World Wide Web in 1995. This new network service can be utilised at the everyday work in all aspects even in the business life, and it has been settled already during the previous years [17]. The other services in the Net make possible the quick real time communication between the experts, business partners and friends.

The information management gets a new meaning with altered characteristics, as follows

1. *The concept of the distributed information*
   The information distribution, the team consulting has great stimulating power: groups formed on the network with equal rights (1) discuss different kinds of problems, (2) send expert knowledge and solutions to each other and (3) the employees knowing the requirements of the product take more responsibility for the high quality.

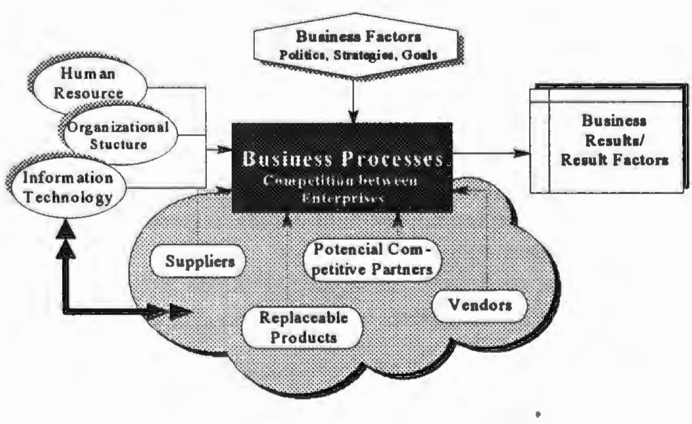


Figure 3. The IT as a competitive factor

2. *Competitive advantages*
   The competitive advantages derived from network services appear indirectly. In the competitive advantage model Porter emphasises the importance and the definite role of the top management

(1) using the information for getting competitive advantages, (2) in decision-making connec with the IT development, (3) for modernising, installing and applying the information infra ture [9]. So we can definitely say, that the information science and technology has strategic i tance, and by the end of the Century it becomes the main peremptory condition for the survi of the businesses (See Figure 3).

3. *Connections, co-operation*

From the leader's point of view the most effective resource is the possibility for their experts to in contact with others (experts, business partners, potential customers and suppliers) all over the world.

As we can see there are a lot of questions waiting for reply and to analyse them, for example: How does the digital revolution contribute to the planning and realisation of the management strate How does the globalisation of the society and economy influence the enterprises, their operationa effectivity? What do the managers think about their new tasks, the always renewing expectatio How do they react to the challenges? How do they see the strength, problems and threats at the business? What opinion do they have about their own competitive situation and the future of venture? What are the most important tasks at the beginning of the new thousandth?

Last year we made a survey among the top managers in Hungary in order to get the answer for th questions.

3. Information Management at the Enterprises in Hungary

In the year 1997 we interviewed with the students of Széchenyi István College 856 leaders of diffe ent kind of enterprises in Hungary, so there are hundreds of talks with managers behind the res of the analysis and conclusions. First of all we had to choose the right groups which show the real Hu garian situation. To sign the enterprises we used *the statistical empirical sampling method* bas the data concerning to the Reports of Hungarian Central Statistical Office. With this selection we could garantee, that our results show the Hungarian realty, and do not contain any distortion factor.

During the interviews with the managers we could get a lot of very useful and important inform about the ideas, goals, operation processes, activity of the firms as follows:

- the business strategic plans, mission and vision,
- the innovative willingness of the management,
- the skill of experts working in control and decision making activity, the used methodology
- the importance of the information and IT,
- the information management activity, the applied IT methods and tools,
- the methodology used by the computer based decision preparing work, the way of decisi making, the risk behaviour.

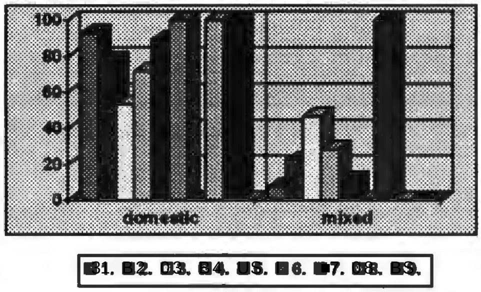
Beside the above mentioned factors we put the emphasis on exploring and analysing the parameters, which can be the base for an entire competitive analysis. As the extent of this paper does not let me write about all of the results [14], [15], I should like to focus on those parts of the research, whi are in connection with the information management, the always stronger competition, the reaction the challenge of the information society and the behaviour of the managers.

nections, getting information, communication

The Hungarian enterprises taken part in this survey are different in the number of employees (range from one to some thousand), in owner and in activity. Analysing the connection between the society formation and the direction of the personal contact we could see, that a great number of enterprises in Hungary have international partners as the Figure 4. shows.

The Way of Connection and Communication			
	form of the company	domestic	mixed
1.	private enterprise	92,7%	7,3%
2.	public company.	77,7%	22,3%
3.	stock company	53,4%	46,6%
4.	limited company.	71,6%	28,4%
5.	family enterprise	89,0%	11%
6.	syndicate	100%	-
7.	joint venture	-	100%
8.	co-operative	100%	-
9.	state budget institute	100%	-
		Source: Input 1998.	

Figure 4. Features of the enterprises in Hungary



Analysing the results from another point of view we do not see significant difference between the domestic and foreign owned businesses by the way of communication, and the exchange of information. But we have to point to the relatively high ratio of *the way of personal contact* which is 33% at the domestic owned firms and 28% at the firms working in international contact. *The telephone calls* play a great role (46% and 41%)[1], and the employees usually write traditional, so called *"snail mail"* letters (14% and 21%). It is growing the use of *faxes*, but it is now on a quite low level yet (6% and 9%). It is regrettable, that *the use of electronic mail* is not yet wide spread, only the 1-2% of the enterprises communicate by this way.

As a comparison the geographically isolated partners in the American type of economic cultures the services of the computer networks are the most important tools in communicating between the partners appearing on the market. These enterprises are connected with each other not only by EDI systems, but most of them are linked to the Internet network, and they use their services, as E-Mail, real time communication, Web advertising and other on-line possibilities and transactions, as the teleworking, tele-teaching, tele-scoping and civil administration.

Financial transactions

The situation is similar to those in analysing the communication tools, the interviewed managers informed us about the use of traditional remittance ways. The main problem is not always the lack of intention but the lack of the up to date and secure infrastructure and the high investment costs. But if we compare our situation to the services of the well developed west American banks our position is not too bad. By a survey on the west coast in the USA in the Year 1997 hardly more

[1] The first number concerns the domestic owned enterprises which do not have foreign partners, and the second one refers to the others with international connections.

than 50% of the banks offer electronic on line services, where 59% of the clients use these possibilities for getting information, and only 27% of them (27% of 50%!) make the on line remittance.

In the year 1991 the GIRO Co. developed in Hungary a network linked the Hungarian banks to each other in order to make the possibility for the clearing account. But the client expect a much higher level to arrange their private and business financial cases, as it is available by the up to date technological possibilities (ATM, POS, home banking, client terminals).

Figure 5. Financial transactions and the sale volume

sales volume in mFt→	0-10	11-50	51-100	101-200	>200	Sum
payment by cash	59%	62%	47%	43%	34%	52%
traditional remittance	39%	33%	46%	57%	64%	45%
on line remittance	2%	5%	7%	0	2%	3%

Let us examine the today's situation in Hungary! There is only 3% of the firms who use the on line bank services, but 87% of the managers expressed their intention to use the network bank possibilities in the near future. By the survey the 52% of the enterprises pay mainly *by cash*, 45% make their remittance on the traditional way. These ratios do not show significant differences even we examine the businesses in different classification for example in groups by the sale value in million of Ft (See Figure 5.).

Improvement of IT, connections to the computer networks

The main focus of the management decision making strategy is to ensure the expected measure of efficiency. But in the most cases it is not so easy to define this degree, because the effectiveness of the investment into new technologies can not be proved directly. The activity of different business systems is very complex, and the reorganisation of management hierarchy and the use of modern IT are only two of those components. We could see significant differences in the degree of the risk taken: 26% of the interviewed persons declared, that it is not worth to pay any money for IT development. In this group there are 92% ratio of those, who have not any IT responsible organisation beyond the enterprise, and where the decision preparing work (computing and analysing) is made by the managers themselves. But I find positive that only 12% think that the IT investment will not be recovered and 42,5% are convinced that the investment into the IT is the main succes factor.

Figure 6.

We are not yet a fully networked country as we can see from the results of the survey. The 84% did not join to any computer networks, mostly because they think that the recovering of the investment and the running costs are much higher than the efficiency received from the applications, but there were only 8% who does not know anything about the computer network possibilities. The Figure 6. shows the distribution ratios of the used Internet services.

Computing based decision preparing process

In order to establish the management decisions the 80% of the leaders apply the methods of statistic, operation research and economic analysis consciously. 17% of them try to find the optimal solution of different problems by *the operation research* methodology, 34% work with *economic analysis*, and 32% think, that *the controlling* methods are important tools for planning, controlling the procedures, co-ordinating the work and managing successfully.

It is good to see, that 17% of the enterprises use *simulation methods* for reducing the unexpected conclusions of the business risk. The managers recognise the benefits of this possibility by which they can simulate with computers the real processes, make prognosis and they can see the expectable conclusions without any risk and any unnecessary losses. The results of the survey show that more and more manager recognise, that the business processes have to fit flexible to the continuously changing circumstances and environment, that the problems has to be solved on a creative and innovative way in order to reach the strategic goals.

4. Conclusion, Future Trends

As we can see from the analysis, the society and the economy have been changing from the roots, and the high quality of the work, the use of the innovative possibilities, the application of the new technologies, the comparison analysis between the plans and the performance have become the basic condition of survive. The enterprises applying the up-to-date methods, tools and technologies, the services of the computer networks undergo a serious change as well, the traditional organisation hierarchy has to take a flexible form, in which the team-work, the close co-operation and the real time connection between the business partners all over the world and the divided decision making activity get the main importance. This common work provides international presence even for the small enterprises and the real time communication and data exchange between the fairest points of the world. The businesses aiming at realisation of long term strategic goals can satisfy the competitive conditions only if they fight against the technological challenges and connect themselves with the application of the high-tech products to the progressively developing international social-economic circulation.

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Panel

Electronic Commerce – The Role of Standards

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INTERNATIONAL STANDARDS NEEDED TO SUPPORT ELECTRONIC COMMERCE

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Abstract

This paper is based on the recent report of the ISO/IEC JTC1 Business Team on Electronic Commerce to its parent committee ISO/IEC JTC1. JTC1 is the Joint Technical committee in ISO which is responsible for standards in Information Technology. There are numerous other Technical Committees (apart from JTC1) which are responsible for standards in other areas.

The Business Team was formed by JTC1 in June 1998. The charter of the Business Team was quite simply to advise JTC1 on the standardization action needed to support electronic commerce. The Team was required to deliver its report within one year.

The complete report [1] as prepared by the Business Team contains 74 pages. The Business Team report identifies the following five scenarios for the use of electronic commerce:

- *a) Business to business*
- *b) Business to public administration*
- *c) Individual to business*
- *d) Individual to public administration*
- *e) Public administration to public administration*

The team made and early decision (in view of the time constraint on its work) to concentrate the scenario "individual to business".

This short paper focuses only on the 34 specific work items which are identified in the report. Much of the text in this paper is adapted from the report. The complete report contained a prioritization of the work items proposed. This prioritization was neither discussed nor agreed by the Business Team and is therefore omitted from this paper.

The report also contains discussion of the possible placement of the work items in various technical committees and sub-committees. Since this would not be of

interest to readers who are not familiar with the structure of ISO, all su discussion has been omitted.

1 Areas in which standards are required

The following key topic areas have been identified in which requirements for standardization ex

A) User Interfaces

- Icons
- Dialogue design principles
- Customer profiles

B) Basic functions

- Trading protocols
- Payment methods
- Security mechanisms
- Identification and authentication
- Auditing and record keeping

C) Definition and encoding of data and other objects

- IT-enablement of existing standards
- Techniques for defining message semantics
- Localization
- Registration authorities
- Value domains needed in Electronic Commerce.

2 Categories of standard

For the purposes of this paper, it is useful to identify three broad categories of standard needed to support Electronic Commerce:

a) sector-specific (S)
b) cross-sectoral (C)
c) IT infrastructure (I)

Standards already exist in each of these categories, some of which were developed with the specific aim of supporting Electronic Commerce and some of which were developed (or at least started) before Electronic Commerce became accepted as a meaningful concept.

A sector-specific standard (for the purpose of this paper) is identified as a standard which is specific to a sector such as banking, health care, libraries, travel or tourism. It is important that sectors not conventionally thought of as "commerce" are also considered.

A cross-sectoral standard is a standard which is relevant to more than one sector but which is not part of the IT infrastructure.

A standard in the category IT infrastructure is a standard which is relevant to information technology and potentially to any information system which may be designed and implemented to support the activities in any sector (including activities relevant to the design, implementation and operation of information systems).

For the purposes of this report, an IT infrastructure standard is a standard which may be used to support Electronic Commerce.

It should be noted that certain standards in the IT infrastructure category are needed to define standards in the other two categories and that such standards will typically also be usable outside the broad area of Electronic Commerce.

3 Category A: User interfaces

To facilitate a minimum level of human-system interaction, there is a need for standardization work in the following four areas:

- a) user interface elements,
- b) adaptable user interfaces through encoding of user requirements,
- c) usability,
- d) end user participation in the design process.

The above areas are closely interrelated and products based on the standards should therefore be able to work together.

There are standards existing or under development that may appear to cover some of the above elements. However, many of these existing standards were developed for the office environment, for trained office workers, and for the PC. These standards may not be relevant for the (untrained) Consumer, in a home environment, using delivery mechanisms other than the PC (smart phone, WEB TV, mobile phone, etc.). Products based on existing standards may not be able to work together.

The following high level work item is identified:

Work item A.1: *Review existing and emerging standards regarding user interfaces, formal and de facto, to establish the status of work in this area and their inter-working. Establish their relevance from a consumer/user interface perspective in a home environment, using also delivery mechanisms other than a PC.*

Pending the results of this, new work items may be needed with respect to the categories above.

3.1 User interface elements

The focus of BT-EC on the "individual to business" aspects of electronic commerce has emphasized the importance of addressing key components of the "Human - Information System Interface".

Evaluation of the following requirements and their resolution through standards will help.

a) To assist individual consumers in their interaction and use of systems utilized to deliver electronic commerce-based goods and services;
b) To promote consumer confidence in systems supporting electronic commerce;
c) To facilitate efficient use of IT systems in support of electronic commerce:
d) To reduce significantly and minimize the probability of errors when individuals engage in Electronic Commerce;
e) To improve consumer learnability and familiarity with electronic commerce.

The following sub-sections identify user interface elements required to facilitate interaction between humans and IT systems interaction in support of electronic commerce.

Metaphors provide a relevant image of how the system works (e.g. desk top metaphor for office systems, filing cabinet for database, etc.) - comprising a desktop. Metaphors are often supported by underlying icons.

There are three categories of interrelated icons to be considered; one set is specifically for facilitating interaction, one set is for representing certification (e.g. copyright, Quality of Service, Usability) and the third is for facilitating navigational aspects (page forward, page back, scrolling).

The functionality of the icons (opening, closing, moving, etc.) needs consideration. Icons can be presented visually (on screen) and/or audibly (using what might be called "earcons") e.g. as tones, alerts, etc.

Work item A.2: *Develop a set of metaphors that are relevant for different domains within Electronic Commerce (e.g. shopping, travelling , ordering, searching, etc.) Existing desktop metaphors (office environment) may not be relevant for the consumer (home) environment, nor for other delivery mechanisms (smart phone, Web TV).*

Work item A.3: *Develop a list of functions to be represented by each of the three categories of icons; namely: (1) facilitating interaction; (2) representing certifications; and (3) facilitating navigational aspects. Provide a functional description of these icons and provide design examples, both for visually represented icons and auditory ones (earcons). Define the grammatical rules for how these icons can be opened, closed, moved, emptied, etc. Icons to be developed in accordance with existing relevant standards. Relevant standards include not only office system standards, but also standards related to the design of information for the public.*

Dialogue design principles for ensuring good human-system interaction across several delivery mechanisms (PC, TV, phone) and how to implement them are needed. This includes principles for navigation e.g. procedures and sequence for getting into the system, navigating (back, forward, return, exiting and aborting). Some of these navigational principles could be represented by icons (e.g. scrolling).

Work item A.4: *Review existing dialogue design principles for office systems (ISO 9241-10) and self-service card-based systems (prEN 1332-1). Adapt these and others to consumers in a home environment. Determine which navigational aids are needed and standardize their representation (e.g. icons) and functionality.*

3.2 Encoding customer profiles

In order to achieve a user interface that is adapted to the end user, there is a need to develop a standard way of representing encoded customer profiles. The types and formatting of data to be included in such profiles needs to be standardized. It is necessary to consider customer class profiles and individual customer profiles.

These profiles would be referenced by computerized information systems used for Electronic Commerce in order to determine the way in which output from the system (and input to the system) needs to be represented for users.

Examples of the types of data to be included in such profiles are language preference, interface complexity, character size, colour preference and colours to be avoided. Examples of special needs include voice output, sound amplification, and choice of input/output devices.

When output is presented to a customer for whom no profile exists, a standardized default representation should be used. When both an individual profile and a class profile are available it would be necessary to resolve the potential conflict - typically by using the individual profile.

Consumer rights profiles will have an influence on which customer class profiles will be needed.

The consumer should be able to check the profile and make or have made required changes. The profiles should not be captured by the terminal or server.

Work item A.5: *Develop an approach to defining customer class profiles and individual customer profiles.*

This work item is part of the IT infrastructure which is needed to support Electronic Commerce. With respect to user profiles pertaining to "individuals", the BT-EC assumes that standardization work in this area will support applicable privacy and data protection requirements.

Work item A.6: *Develop a starter set of customer class profiles using the approach defined in work item A.2.*

Work item A.6 should be for cross-sector customer class profiles.

This generally applies to textual information pertaining to icons, navigational aids and product labelling.

Work item A.7: *Develop a standard for the unique, unambiguous and linguistically neutral identification and referencing of all icons, navigational aids and prompt labelling in an IT-enabled manner including the ability to support computational integrity. Such a standard or standards must also include a facility to support the assignment of multi-lingual language equivalents appropriate to localization requirements.*

3.3 Easy connectivity for input/output devices

Easy connectivity for input/output devices will enhance accessibility for all users, including disabled and elderly people.

Work item A.8: *Standardize plug compatibility for different input/output devices (from keyboards, joysticks to Braille readers/printers, speakers) and different delivery mechanisms (TV, PC, telephone). Develop appropriate software standards to facilitate plug compatibility.*

3.4 Other Elements of a multi-cultural nature

These are elements of a multi-cultural nature not covered above, e.g. societal. These include, but are not limited to the following:

date/time formats,
numeric and non-monetary formatting,
monetary formatting,
sorting and searching rules,
local legal requirements,
local consumer /supplier requirements religion,

3.5 Testing and conformance of user interfaces

Human-system interfaces need to be tested for usability. Usability is defined as the extent to which a product/system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. Ease of use is measured by usability metrics.

Usability metrics should measure objectively features associated with usability, such as time taken to perform a task, number of errors, task completion as well as subjective measures. The metrics (and existing usability standards) do not set levels of usability.

Existing standards were developed for trained office workers, in an office environment performing office related tasks.

Work item A.9: *Review existing standards and industry practice regarding usability. Identify the right measures for objective measurement of usability (error rate, failure of* *transaction, time etc.). Adapt and/or develop tools for the objective and subjective measurement of usability for Electronic Commerce.*

4 Category B: Basic functions

4.1 Trading protocol

A Customer Merchant Trading protocol defines the message exchanges between two partners (customer, merchant) and their respective financial institutions when they do business together, i.e. when they negotiate the contents of a planned contract, make a contract, arrange payment and delivery. The focus is on the Customer Merchant message exchanges, but other agents (financial service providers, systems organizing delivery, trusted-third-party systems acting as mediators) may join the group of involved agents.

A continuous sequence of message exchanges which is somehow self-contained by its functional meaning and its effects is called a "transaction".

The next larger dynamic business context between two specific partners, i.e. all the message flow and the build-up and maintenance of a documentation around a single contract is called here a "business affair". Typically many transactions belong to a business affair the lifetime of which may span over month or even years.

The above definition of the term "transaction" is attempts to capture the meaning of the term as used (though not defined explicitly) in the OTP-documents published in January 1998. Another definition of 'transaction' has also been provided to the Team:

A transaction has the following components:

- Business process: Customary steps and flow of a certain type of business. These steps are associated with information bundles and financial events.
- Information bundles: Information attached to the steps of the business process or to the financial events. The method of attaching this information is to be described by standards, but the format of the attachment itself might not, in all instances, be described by these standards, i.e., arbitrary information can be attached.
- Financial events: Debits and credits associated with the accounting systems of the parties of the transaction.

The trading protocol is driven by the complex states of the two partners. The state sequences represent the progress of the business affair. This, in general, includes the responsibility of the partners to store securely data objects or documents describing the current state of the business affair as seen by the respective partner.

The task of developing a standardized trading protocol comprises at least three important sub-goals:

- defining appropriate Electronic Commerce -functionality (especially as to be offered to the customers).

- assuring interoperability between ad hoc partners (especially for customer/meR^ pairs)

- limiting unnecessary diversity of mechanisms

Unnecessary diversity occurs if several essentially equivalent mechanisms (protocols) are prestal and are required to be implemented for achieving a high degree of interoperability. Unnecesalf diversity drives up costs in different ways (production and operation of equipment, custonnf intellectual efforts, etc.).

Technically, a principal provision of interoperability may go together with a high degree of unw cessary diversity. A small universal protocol made only for agreeing on one of a set of protocols to be used next will in principle achieve interoperability, on the condition that the two partners cii always find one of the "lower order" protocols they can both operate. Selecting sub-protocdimaj go on recursively.

The list of customer functions for Electronic Commerce includes:

- negotiating contents of purchase contracts - omitting aspects such as langage adaptation, anonymity, which protocols are available, (for example WWW-techniqu^);

- receiving, producing and storing legally binding statements, such as purchase contract, by applying certified electronic signatures;

- making payments, in other words agreeing on and exchanging of payment ob^ recognizable within the electronic commerce model;

- arranging delivery;

- doing business while staying anonymous or even untraceable (especially the cu$too| towards the merchant);

- recovering from communication or system failure especially in the situation of critial uncertainty (such as uncertainty whether a high-value contract is made or not);

- establishing provisions for dispute (also referred to as “customer care”);

- managing trust prior to contract.

A restriction of unnecessary diversity would enhance the achievable degree of interoperaMjf (equivalent to success rate when two ad hoc partners try to inter-operate). It would reduce all kinds of costs for participants including software vendors. Moreover, a joint effort of system and softunt vendors, of financial service providers, consumer representatives etc. to define the appFopK functionality could help to solve this task and to reduce the costs going along with it. The following work item is proposed.

Work item B.1: *Develop a trading protocol satisfying the above requirements. The trading protocol to be developed should try to reach the three sub-goals above, wherever possible.*

The most prominent sub-areas of the trading protocol and its related service interfaces are the payment procedures and the security mechanisms which are further elaborated below.

The following are known related activities in the marketplace:

- CommerceNet
- Electronic Commerce Promotion Council of Japan (ECOM)
- Java Electronic Commerce Framework
- Object Management Group (OMG)
- Open Buying on the Internet (OBI)
- Open Trading Protocol (OTP)
- Secure Electronic Market Place for Europe (SEMPER)

Many of these systems and specifications are incompatible and do not inter-operate.

4.2 Payment methods

A number of payment protocols for different purposes and with different characteristics have reached or are about to reach practical applicability. They can be used as sub-protocols of the trading protocol. Their systematic invocability in the trading protocol will be an important part of its design. The multitude of payment methods causes consumers to have different and unique electronic purses to interface with their corresponding electronic point-of-sale equivalent on the merchant side. This results in the consumer having to supply the same payment information in multiple instances.

To promote Electronic Commerce for the Individual-to-Business category globally, it would be ideal to have a single payment protocol applicable to all forms of Electronic Commerce and globally accepted. Efforts are being undertaken at the national body level. Whether these will be financially successful and accepted in the marketplace or not, for a transitory period the need exists to encapsulate a number of such payment schemes within a trading protocol.

Work item B.2: *Develop a limited set of standard payment methods, including standard payment objects.*

The following are known related activities in the marketplace:

- CyberCash, CyberCoin
- DigiCash ecash
- E-check
- e-COMM
- Electronic Purse Systems (e.g., Mondex, GeldKarte, Clip, prEN 1546)
- EMV
- Home Banking Computer Interface (HBCI)

- JEPI
- Millicent
- Proton
- Secure Electronic Transactions (SET)
- Visa Cash

4.3 Security mechanisms

A minimum common ground must be defined for Electronic Commerce security in order to provide for reliable, inter-operable operations. This includes as a minimum a set of common inter-operable mechanisms for

- authentication, integrity and digital signatures,
- supporting key management infrastructure.

In addition to the above, issues such as confidentiality, data protection and privacy need to be addressed to fulfil regional and national regulation or self-regulation, or legislation.

4.4 Digital signatures

The technical basis for non-repudiatable agreements (reachable by producing and exchanging non-repudiatable digitally represented documents) are digital signature algorithms. Digital signatures provide a method of "signing" digital media such that the "signer" can be identified and/or validated. A digital certificate relates the "signed" digital media to the well-known "signer" -- the meaning of the certificate is dependent upon the application.

Though some such algorithms are well known and some have already been standardized, their application by individuals in a potentially hostile or at least untrustworthy system environment is a technical and organizational problem that remains to be solved.

Work items are identified to make digital signatures practically available for customer-merchant oriented Electronic Commerce.

Many Electronic Commerce operations use digital signatures and certificates, not just payment systems, so there will be many schemes, e.g., different algorithms and key sizes.

Work item B.3: *Harmonize digital signature methods.*

Methods and management techniques are necessary to support widespread, large scale deployment of digital keys.

Work item B.4: *Develop standards for key management infrastructure.*

Work item B.5: *Develop standards for customer's means to sign Electronic Commerce documents including multimedia documents in an inherently untrustworthy environment.*

4.5 Confidentiality

To support confidentiality, a number of encryption methods (standardized or non-standardized) are already available. Whether or not Electronic Commerce leads to special and additional requirements for new methods could not be resolved.

With respect to anonymity, it was not possible to produce specific requirements for standardization. However, the following conclusions relative to anonymity were drawn:

- Even if financial service providers offer a high degree of data protection, consumers may, in certain instances, have the desire to stay anonymous towards the financial institution, if legally possible, when doing certain forms of Electronic Commerce.

- No requirement was identified as for a merchant to stay anonymous vis-à-vis any of the trading partners.

4.6 Identification

Certain entities (especially participants like customers, merchants, financial service providers, trusted third parties etc.) and certain items (processes and data objects like business affairs, transaction records, payment procedures etc.) will each need a specific globally unique and verifiable identifiers (GUID).

The qualification "globally unique" does not exclude that an entity or an item has several such identifiers. It means that such an identifier, in a large but precisely specified context such as Electronic Commerce in the Internet", is generated and attributed at most once and never again in the specified context.

When developing an identification scheme, the following two different may be considered.

- Each GUID is formed in such a way that it is possible to search on the basis of other available knowledge about the identified entity or item. An example is the process of identifying a person by his name plus the date of birth, plus a (short) suffix.

- Each GUID is in no way correlated to any properties of the identified entity or item. An example is when the identifier is a serial number taken from a single global counter.

Wherever possible and in due consideration of privacy concerns, the identification procedures should be defined in such a way that they support searching for GUIDs on the basis of typically available other information on the identified entities or items.

Work item B.6: *Investigate which entities or items need EC- specific globally unique identification. Define different procedures for generating and attributing globally unique identifiers. For certain categories of such identifiers, the one-to-one* *correspondence to other identifiers (from other identification schemes) i need trustworthy certification.*

4.7 Authentication

Authentication is defined as the provision of assurance of the claimed identity of an enti Authentication concerns verifying and/or validating that a user, system object, etc. are the identi that they claim they are. Many methods are possible, e.g., passwords, certified keys, biometric

Work item B.7: *Develop a common specification for verifying and validating the source of data object and/or the identity of a communication partner in the Electron Commerce context (authentication; see also Work item B.6).*

4.8 Encryption

Encryption is a coding technique that obscures the content. Typically, encryption is used to imp ment confidentiality.

Work item B.8: *Develop encryption algorithms that satisfy cross-sectoral and sector-sp needs.*

Work item B.9: *Develop recovery methods necessary for recovering from errors, such network outage, for encrypted blocks and streams.*

No additional work is needed in the area of integrating new algorithm definitions.

4.9 Other security issues

There are significant legal problems that impede or inhibit wide-spread deployment of common en cryption techniques, e.g., usage control and export control. This issue will not and should not be a dressed by standardization.

4.10 Authorization and capabilities

Authorization concerns the valid operations that can be performed by a user, system, object, etc Capabilities concern the valid operations that can be performed on an object.

Work item B.10: *Develop a common specification for validating which operations can be per formed by and on components, e.g., users, systems, events, transactions.*

4.11 Security algorithm and attribute selection

Electronic commerce systems will use various security methods, and support various security levels and qualities. Both users and systems will need to select from, say, different algorithms and key lengths, depending on the needs of the user, system, or transaction.

Work item B.11: *Develop a standardized method for selecting the security algorithm and security attributes, e.g., key size (security quality of service).*

4.12 Auditing, record keeping

Many regulatory agencies require financial institutions to maintain permanent records that cannot be changed, i.e., tamper-proof or tamper-evident. Currently, many records are stored in non-digital form, such as microfilm. While there exist write-once media standards (e.g., CD-ROM), these standards might not be appropriate for Electronic Commerce because additional security features are required.

Work item B.12: *Develop standards for digital media that may be written only once that meets the security requirements of Electronic Commerce, such as tamper-proof, tamper-evident media.*

4.13 Auditing and traceability

Successful financial systems require common methods, techniques, and practices for validating all components of the data processing system to ensure financial integrity of the electronic commerce system. The components include: users, systems, objects, transactions, communications networks, currency (and other objects of value) several auditing techniques.

Common techniques and methods are required for consistent auditing of Electronic Commerce components. Common system tracing methods enable analysis of the past (e.g., forensic analysis), present (e.g., monitoring and alarms), and future (e.g., thresholds and problem anticipation).

Work item B.13: *Develop common auditing and tracing standards that support common analysis of Electronic Commerce components in the past (e.g., forensic analysis), present (e.g., monitoring and alarms), and future (e.g., thresholds and problem anticipation).*

5 Category C: Definition and encoding of data and other objects

Some of the following requirements primarily result from Electronic Commerce in the Business-to-Business or Administration domain.

- identification of all value domains involved in Electronic Commerce;

- IT-enablement of existing standards for widely used value domains (such as countries, currencies, languages) for use in Electronic Commerce;
- widely used value domains for which no standards exist such as jurisdictional domains affecting Electronic Commerce;
- complete semantics of data types and message types used in Electronic Commerce;
- localization for a specific point of use (for example a mix of jurisdictions, languages,) of the terms available for referring to all information used in Electronic Commerce;
- arrangements for registering the results of work developed in e) and f) above.

5.1 IT-enablement of existing standards for encodable value domains

Many of the value domains needed for use in Electronic Commerce are bounded sets in the sense that the value domain and the set of permitted values in that domain are pre-defined and enumerated in the standard. Most of these are of the nature of "codes representing X". From a global Electronic Commerce perspective, standardization work is required for the identification and referencing of such objects in an unambiguous, linguistically neutral, and an IT-processable manner. Which is suitable for Electronic Commerce.

These standards need to be re-cast in a computer processable form in order to support more fully the objective of computational integrity, a key part of IT-enablement and in a manner which supports localization and multi-lingual requirements.

Other value domains are unbounded in the sense that the set of possible values cannot be prescribed. A standard may be defined for the format of the values in such a domain.

Work item C.1: ***Standardize an approach for the identification and mapping of encodable value domains.***

Work item C.1 is a part of the IT infrastructure for Electronic Commerce.

Work item C.2: ***Develop standards for IT-enablement of existing standards using the approach defined in the standard for Work Item C.1.***

Work Item C.2 represents the application and use by ISO Technical Committees of JTC 1 standard(s), i.e., tools. When the above noted examples are IT-enablement, the JTC 1 tool set of standards will be improved.

5.2 Identification and Mapping of Jurisdictional Domains

Electronic commerce, like present-day commerce, has to comply with the requirements of the jurisdictions which impact the way in which Electronic Commerce is carried out. In addition to jurisdictions which have a physical, i.e., geographic, dimension, there are jurisdictions bounded by type of goods or services dimensions.

Examples of jurisdictions with (1) a physical dimension are the European Union, NAFTA, California, Punjab, etc., (2) those with a goods dimension is the Multi-Fibre Textile Agreement (MFTA); and, (3) those of services dimension are found in the transportation, banking, procurement, etc., sectors.

Work Item C.3: ***Standardize the identification and mapping of the various categories of jurisdictional domains (with priority on those impacting several sectors of Electronic Commerce).***

Work Item C.3 is part of the IT infrastructure. It is a standard tool to be utilized by bodies with sectoral and cross-sectoral responsibilities as well as bodies wishing to start the process of IT-enablement for electronic commerce of their jurisdictional domain".

Definition techniques for defining data and message semantics

Standardized techniques are needed for defining the semantic constraints to be imposed on the data elements comprising the contents of message types used in Electronic Commerce. These techniques need to be compatible and consistent with the techniques used to define the data as used in the computer information systems which need to be able to inter-operate in Electronic Commerce.

Standards exist for defining message formats but these do not enable the complete message semantics which may be quite complex and indeed open to interpretation.

Examples of the kind of semantic constraints which need to be expressed as part of message definition are the following.

a) A data element in a message must take one of the values which are prescribed in a standard for the value domain to which the data element corresponds;

b) A data element in one part of a message must take the same value as that for a matchable data element in another part of the message;

c) The values in two or more data elements in a message must collectively satisfy a potentially complex validation criterion based on a predefined Boolean condition expressed on these fields.

Work item C.4: ***Develop a standard facility for use in defining the kinds of messages used in Electronic Commerce.***

Work item C.4 is part of the IT infrastructure which is needed to support Electronic Commerce.

Work item C.5: ***Develop a set of message definition standards using the facility defined in work item C.4.***

Work item C.5 should be for cross-sectoral messages.

5.3 Localization

Terms and names found in standards are not linguistically neutral, nor are they IT-processable. In Electronic Commerce, there are specific local requirements which need to be identified. Collectively these requirements and other aspects are referenced here as localization factors.

There is a need to be able to cast international standards in a manner which on the one hand supports unique, unambiguous and linguistically neutral identification and referencing of objects and, on the other hand, supports the development of designation of such objects by terms and names in support of localization and multi-lingual requirements, i.e., in addition to the ISO official languages.

Work item C.6: ***Define an approach for defining localization factors for the local use of Electronic Commerce.***

Work item C.6 is part of the IT infrastructure which is needed to support Electronic Commerce and should be developed in an appropriate JTC 1 committee.

Specific individual standards can only be developed locally and when a specific need is identified. The approach developed in C.6 should be used.

5.4 Registration authorities

Both customer profile standards and localization factor standards are likely to proliferate and it is necessary to define a process of registering such standards so that they may be available to other users.

Work item C.7: ***Define how to register and maintain various aspects of the value domains defined in the customer profile standards and in standards for localization factors.***

5.5 Definition and encoding of data and other objects

Identification of value domains needed for use in Electronic Commerce

Work item C.8: ***Standardize an approach to defining sets of values for unbounded domains and for defining the format of the sets of values for unbounded value domains.***

Work item C.8 is a part of the IT infrastructure for Electronic Commerce

Work item C.9: ***Define bounded value domains used in two or more sectors of Electronic Commerce.***

Work item C.10: ***Identify requirements for the handling of unbounded value domains used in two or more sectors of Electronic Commerce.***

Work item C.11: ***Define bounded value domains for use in a specific sector of Electronic Commerce.***

Work item C.12: ***Identify requirements for the handling of unbounded domains for use in a specific sector of Electronic Commerce.***

Work items C.9 and C.11 are cross-sectoral. These should make use of the approach standardized in work item C.8.

6 Reference

[1] ISO/IEC JTC1 N5296. "Report to JTC1: Work on Electronic Commerce to be initiated." (Copies of this report can be downloaded from the JTC1 World Wide Web page. The URL is http://www.jtc1.org. No password is required to download this document.

ENABLING TECHNOLOGIES FOR ELECTRONIC COMMERCE

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Electronic commerce is a rapidly growing research and development area of high practice relevance. A major challenge in successfully designing electronic commerce applications is to identify mature enabling technologies and to integrate them into a common application framework. In this paper, three of these enabling technologies for electronic commerce are explored. First, workflow management systems for covering the process flow aspect of electronic commerce, second database and open hypermedia technology for realizing electronic product catalogues and third data mining technology for supporting web usage tracking.

1. Introduction

Electronic Commerce (EC) has been an important application of information and communication technology since several years. But, it has been the emergence of the world-wide available Internet and its several services which makes EC the real killer application of our days [Pyle96]. In its most general definition, EC comprises all selling and buying activities on the Internet. According to a study of the International Data Corporation $ 8 billion worth of business was transacted on the Internet in 1997, and that figure will grow to $ 333 billion by 2002 [IDC98]. EC appears in various forms ranging from commercial transactions between businesses via the retail sale of tangible goods, to digital delivery of goods and services. Businesses in virtually every sector of economy are beginning to use the Internet to cut the cost of purchasing, manage supplier relationships, streamline logistics and inventory, plan production, and reach new and existing customers more effectively [Adam98].

A major challenge in successfully designing EC applications is to identify appropriate *building block technologies* and to integrate them into a *common application framework* [Kama97], [Muth98b]. In this respect, the existence of standards constitutes an important selection criteria since interoperability is of major concern in the area of EC. In general, requirements posed on these basic technologies are numerous and origin from the unique nature of EC, which is characterized by distributed, autonomous, and heterogeneous information sources, vast amounts of hypermedia data, a wide range of user's specialities and abilities, and various services which should be supported [Adam98]. Among these services are suppliers search and negotiation, the establishment of initial contracts, sales, pre- and post-sales support, and secure electronic payment [Doga98].

In this paper three enabling technologies for EC, which seem to have the potential to cope with some of these requirements, are proposed and their current state of the art as well as actual research issues are discussed. First, the *business process flow aspect* of EC is faced by proposing *workflow management systems* to serve as the backbone of an EC system. Second, for the realization of *electronic product catalogues,* which are mainly used during the pre-sales phase of an EC process, the employment of *database* and *open hypermedia techniques* is suggested. Finally, to cope with different user demands and to facilitate personalized marketing efforts, *web usage tracking* by means of *data mining technology* is discussed. Note, that other aspects of an EC system, most notably financial, legal, and social issues, are equally well important but are not the focus of this position paper.

2 Workflow Management Technology For Supporting EC Processes

A major goal of information technology is the effective support of a company's business processes [Geor97]. By making business processes explicit, workflow management systems (WFMS) promise to increase their efficiency and, consequently, to raise productivity and the competitive edge of an organization. WFMS cannot only be applied within an organization. Rather it seems to be natural to see WFMS as the glue between previously independently modelled business processes of different organizations. These so called *inter-organizational workflows* are used for supporting the business processes occurring *between companies and customers* [Muth98b]. This is in line with the general definition of WFMS supporting the design, execution and monitoring of long-lasting business processes that typically involve multiple activities and multiple collaborating persons in a distributed environment, as it is the case for EC [Kapp98]. In general, all phases of an EC business process ranging from pre-sales via sales to post-sales activities should be supported by WFMS in that a unified execution framework is provided for all applications necessary for fulfilling each activity. Two major requirements posed from EC on WFMS are discussed in more detail in the following.

2.1 Adaptability of Workflow Instances and Workflow Types

EC processes, especially their pre-sales and post-sales phases, are to a certain extent unstructured and unpredictable. That is, it is not possible to capture all valid task sequences and possibly recurring exceptional situations in advance. Therefore, deviations from a predefined *workflow type* during a sequence of tasks should be allowed at runtime while preserving *consistency* and *correctness* of the whole business process [Reic97]. This means that a workflow type should constitute some kind of *framework* only allowing to dynamically add and delete tasks to an individual *workflow instance*. For this, all kinds of dependencies between tasks including *control, data,* and *temporal dependencies* have to be taken into consideration as soon as the workflow instance is restructured. Furthermore, since the whole company has to adapt to rapid changes in the business environment, there is a need to dynamically *reengineer and optimize the workflow type itself* while possibly several workflow instances of this type are active. For this purpose, appropriate *migration strategies* as well as *versioning mechanisms* have to be developed [Krad98]. A promising technique to cope with these adaptability requirements are *active mechanisms* in terms of *Event/Condition/Action* rules since they allow for an event-driven realization of context- and time-dependent behaviour, which may be manipulated at runtime [Kapp98].

2.2. Interoperability of WFMS

Since EC workflows involve multiple, autonomous parties, the issue of *interoperability* between different WFMS is of major concern. The *Workflow Management Coalition* [WfMC98] has proposed a first draft of a standard interoperability interface for WFMS, which, however, has two major drawbacks [Groi97]. First, the kind or structure of the data exchanged between the process is not defined. Second, the only form of interaction considered is between two WFMS implementing the standard. Coping with the various requirements on interoperable and distributed execution workflows, however, one should distinguish between different levels of interoperability [Groi97]. These are ranging from *tightly coupled systems* with strict synchronization needs [Gokk9!(J [Muth98a] to *loosely coupled systems* supporting interfaces for the electronic exchange of business documents on the basis of standards such as *Electronic Data Interchange* [Disa97] or the more comprehensive *Open Trading Protocol* [OTP98]. For achieving a tight integration, i.e., to facilitate inter-organizational workflows, the architecture of a WFMS must be *fully distributed* meaning that control concerning a certain workflow instance has to be transferred from one WFMS engine to another, each residing on another site in order to schedule, execute and monitor parts of the workflow instance [Doga98]. Problems that arise in this context are the *unreliability* of the Web in terms of network and web server failures and *inefficiency* since a few thousands workflows per day would not be uncommon [Kama97]. Furthermore, proper concepts for a *correct partitioning and composition of workflow types*, which were originally designed independent of each other, have to be developed. A promising approach for achieving a tight integration seems to be a *wrapper/mediator architecture*, where each system is encapsulated and enriched by a common language such as the *CORBA Interface Definition Language* [Doga98], [Muth98a].

3. Database and Hypermedia Technology for Realizing Electronic Catalogues

Clients of EC systems should quickly and easily obtain all the product data needed to make informed purchase decisions, which is realized by using *electronic product catalogues*. An electronic product catalogue constitutes a GUI, typically a Web page, that allows convenient access to the merchandises of a company. To realize electronic catalogues we propose two technologies, namely *database systems* as the primary storage medium enabled with some interoperable link service via *open hypermedia systems*.

3.1. Electronic Product Data Management

Many existing electronic catalogues are stored together with Hypertext Markup Language (HTML) commands in files only. This approach leads to several drawbacks including maintenance, consistency, concurrency, and authorization problems. At the same time, database systems are strong at supporting consistent multi-user management of distributed multimedia information. They have been in use in a wide range of business areas for years. Given this fact, the idea of combining easy to use GUIs as provided by the Web with state of the art data management facilities appears to be promising [Ehma97]. Large amounts of product data possibly distributed over various sites within the company's intranet could be easily maintained by the vendor in a consistent way. Furthermore, the product data is highly structured due to the underlying database schema and thus can be simply retrieved by means of *precise boolean queries*. What is also required in the context of electronic catalogues is, that the database system supports *multimedia data types* such as images, 3D-objects, animation sequences, audios and videos, along with facilities for optimal storage, access, indexing and retrieval. Concerning retrieval of multimedia data, precise matching must be extended in the direction of *similarity matching* along with *relevance feedback* and *ranked results*. However, database systems still have their drawbacks when it comes down to performance requirements. This is since holding all product data within a database and *generating the HTML pages on the fly* will seriously decrease system performance. Approaches relying on *pre-generation of HTML pages* seem to be more appropriate [Proe98].

3.2. Interoperability of Open Hypermedia Systems

Interoperability is not only important for workflows but is rather crucial for the success of electronic catalogues, too. This means that it should not only be permitted to merge data from within a company but also to let content providers and consumers easily locate and acquire whatever information they desire from other catalogues [Comm97]. The prerequisite for interoperable catalogues is an *industry standard protocol for inter-catalogue communication* on the basis of which queries can be used to locate similar or complementary products in other catalogues offered by other vendors. Such standards, which are already under development (cf., e.g., the *XML* and *RDF* initiatives of the *W3C consortium* [W3C98]), form also the basis of *Open Hypermedia Systems* [Kapp96]. By means of their *link server functionality* every link can perform arbitrary behaviour, such as querying, controlling access to product information contained in remote catalogues and presenting the remote content in context of the original local catalogue by eventually performing some conversion operations. With this, product information drawn from a variety of heterogeneous sources can be presented in a uniform format without requiring the customer to navigate from one web site to another. The major advantage in comparison to a traditional link, e.g., as it is realized with the current http protocol and Web technology, is that although the customer gets information from a remote catalogue, the context of the local catalogue remains and thus the customer doesn't get lost [Comm97].

4 Data Mining Technology for Supporting Web Usage Tracking

The analysis of how users are accessing a Web site is critical for determining *effective marketing strategies*, generating *user profiles* by means of which a Web site can be personalized for a certain customer, and *optimizing the logical structure of the Web site* for all customers. Organizations often collect large volumes of web usage data whereby most of this information is usually generated automatically by *Web servers* in terms of access logs or gathered by means of a *workflow history management component*. Whereas in the latter case, the information gathered already represent meaningful Web transactions, the granularity of the data collected in various logs is too fine and must be therefore grouped into logical units. For discovering *user access patterns* out of Web transactions, *data mining techniques* such as *path analysis*, *association rules*, and *classification rules* may be applied [Cool97]. Once access patterns have been discovered, analysts need appropriate tools and techniques to understand, visualize and interpret them. Since the size of server logs grows quite rapidly, it may not be possible to provide on-line analysis of all access patterns. Hence, there is a need to summarize access patterns to make their on-line analysis feasible. Recent work has shown that the analysis needs of Web usage data may be served by well-known *OLAP techniques* [Chau97].

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Panel

Virtual Organizations ante portás?

Richard Baskerville (Chair)

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Virtual Organizations: Accelerating Organizational Emergence

Richard Baskerville

Abstract

Three distinct concepts are central to virtual organization: the virtual workplace, the virtual team, and the virtual enterprise. The virtual workplace exists in the imaginations of the workers. The virtual team exists only in its potential to become real. The virtual enterprise is a quickly assembled and potentially short-lived collaboration between corporations. The idea of a virtual organization is sometimes conflated with heavy use of productivity IT. The social impact of virtual organization is an important issue. Ultimately, the goal of virtual organization is quick change: enabling the organization to emerge more rapidly in order to better adapt to its environment.

1 Introduction

There are a number of distinct concepts associated with the term "virtual organization" leading to definitional disputes [14]. Several of these concepts have determined distinct streams of research and practical information technology (IT) literature. Although these streams interlock to a certain extent, a problem of cross-conversations arises when the term "virtual organization" arises. The purpose of this paper is to distinguish between three of the important, distinct streams, and discuss the different role of IT in each stream.

2 The Virtual Workplace

In common parlance, the concept of "virtual" refers to something that exists or results in essence or effect, but not in actual fact, form or name. It is basically an idea that is strong enough to produce the same effects as the physical embodiment of the idea among those individuals who share the common thought. A virtual workplace is a form of virtual reality, one that has no physical embodiment, but exists strongly enough in the minds of the workers to have the same effect. They share an imaginary workplace that produces the same effect as would the equivalent physical workplace. Examples of virtual workplaces include virtual offices, virtual laboratories and virtual classrooms [1, 2, 11, 12, 16].

IT enables the virtual workplace by providing mechanisms to help workers develop a shared image of the features in the conceptual workplace. IT provides a essential mechanism that enables this shared image: rich communication. Physical workplaces embody face-to-face communication and the sharing of physical artifacts like whiteboard drawings and specimens. Physical workplaces also facilitate socialization processes that engender belonging and commitment. Virtual workplaces use digital communications: video and audio links, electronic whiteboards, email, chat rooms, etc., as substitutes for physical collocation of the workers.

The essential of virtuality in this electronic workplace is the degree to which the workers share an imagined vision of these communication links as a common space. The virtual workplace becomes a virtual reality when the workers accept the workplace as a shared environment. This acceptance will in turn give rise to the socialization processes and the concomitant belonging by transforming the social reality [6]. This stream of research regards virtual organizations as organizations that depend on virtual workplaces.

3 The Virtual Team

Closer attention to philosophy leads to a slightly different concept of virtuality than found in common parlance. In these terms, the essence of virtuality lies in "a system's potential evolution from being descriptive to being prescriptive" [18, p. 38]. This leads to a view of virtual organizations as one comprised of many virtual teams of workers. A team's virtuality regards the potential for an imagined team to become a real (physical) team. This view is a little closer to the computing concept of virtual memory, one in which the switching capability is centralized [14]. Within any large organization there may be a number of different groups of individuals with the collective skills necessary to satisfy the needs for a particular task. A virtual team is such a potential group. For virtual teams to be effective the organization must be able to quickly explicate its goals and effect a satisfying team that accomplishes each task Effectively switching tasks among (potentially overlapping) teams enables organizations to achieve the flexibility necessary to compete in a marketplace where change is continual [14]. The organization must also be able to effectively switch any necessary resources that the team requires. Virtual teams are one means by which a group of workers can assemble quickly to meet transient or unexpected tasks [8].

IT has two roles in enabling virtual teams. One role involves tracking resources, supporting models, simulations, and other processes necessary for the identification and assignment of workers to virtual teams. This role overlaps to a certain degree with the IT role in knowledge management [4]. IT is necessary to inventory and map the knowledge and skills of the workers in order to enable decision-making about converting a virtual team into a real team. The second role interlocks with the role of IT in providing a virtual workplace for a geographically distributed team. For example, in a global organization, the necessary members of potential teams who fulfill all of the skills requirements may be scattered across the world. The only way to rapidly and effective switch such a team to "reality" may be by switching it to the virtual reality of a virtual workplace. However, virtual workplaces may not be essential if the organization is centralized. Consequently, this stream of research regards virtual organizations as organizations that depend on effective switching between virtual teams of workers.

4 The Virtual Enterprise

This view of virtual organization expands the virtuality switching concept to a broader level, crossing organizational boundaries. In this view, a virtual organization is a virtual company, one in which resources are selectively allocated by cooperating companies where they can be more profitably used [7]. Very much like virtual team organizations, virtual enterprises are motivated by the need to rapidly and flexibly respond to changing marketplace conditions [10]. However, in this case, the need is serviced by rapid formation of a virtual company that endures only as long as it serves its immediate need.

Management of virtual enterprises is closely attuned to an understanding of core competencies of organizations [17]. The idea is to draw each important input of a virtual enterprise from an organization that can provide that particular input from its own repertoire of core competencies [5]. This idea is related to outsourcing in that organizations can devolve their non-core activities to virtual enterprises.

IT is an essential component of virtual enterprises in the roles described above. But particularly to the virtual enterprise concept, IT plays an important role because of the rise of electronic commerce. Virtual enterprises may be entirely launched from IT platforms, e.g., the Web [16]. IT can also play an essential role in tracking and supporting queries into available resources and potential virtual enterprise partners [10].

5 Issues And Problems In Virtual Organizations

5.1 Mistaken Virtuality

There are some common misperceptions of virtual organizations. For example, virtuality is easily conflated with its underlying technology for networking and electronic mobility. Because of their heavy dependence on IT, networked organizations can easily be mistaken for virtual organizations. Virtual organizations may become defined in peoples' minds as flattened organizations that use laptops, email, cell phones and Internet [5]. While such networked organizations may be heavily dependent on IT, their organizational structure may be fairly permanent (lacking virtuality). Similarly, a joint-venture electronic-commerce project between cooperating organizations may be intended to be permanent rather than virtual.

5.2 Social Impacts on Virtual Workers

Early theories of virtual organizations have been decidedly instrumental in the integration of the virtual workers and IT. But virtual workers may have an entirely different social contract with their organizations. Managers cannot control virtual organizations in the same way that they control real organizations. A realignment of the value of trust becomes necessary in virtual organizations. This trust is notable when virtual workers telecommute, requiring a refocus on product rather than process [9]. This has further implications for rewards and sanctions schemes. These schemes may have to be realigned for a virtual workforce. Virtual workers who free-float entirely may become alienated without a home base. This alienation suggests that some industries or functions are more suitable for virtual organizations than others. For example, consulting organizations that are more concerned about obtaining the right professional knowledge at the right time, and do not depend closely on long-term worker bonds to the organization, present a social profile that seems highly suitable for virtuality. In other cases, the alienation implied by virtuality may require more attention to the socialization aspects of virtual organizations. One suggested solution has been the use of explicit social networking as a means to maintain a sense of belonging that may be critical to retention of loyal knowledge workers in virtual organizations [3].

5.3 Economic Impacts on Competition

If virtual enterprises achieve dazzling success, one eventual consequence could be incredible corporate and economic focus, giant boutique corporations that span global boundaries and dominate a tight niche market. This could lead to a shift in competitive form. Whereas today there is direct competition between suppliers of essentially duplicate products, the future marketplace might involve competition among products that are substitutes rather than ideal niche satisfiers. The global availability of virtual workers may also impact the price and condition of labor.

5.4 The Emergence of Virtual Organizations

The potential instrumentality of virtual organization mechanisms may affect the "humanity" with which managers govern their organizations. They may choose to follow an essentially rational economic model in choosing their strategies [15], ignoring the dehumanizing effect of the instrumentality in IT [19], or they could find ways to use virtuality as a means of emancipation [13].

A close examination of the social distinction between "virtual" organizations and "real" organizations discovers a fuzzy boundary between the concepts. An instrumental view of organizations implies that the structure of human organizations is ultimately defined by physical artifacts like organization charts, standards of procedure or computer networks. From this view, alteration of these artifacts results in new patterns of human interaction, perhaps for new purposes. An emergent view of organizations implies that human organizational structure is defined primarily by human behavior, patterns of habitual interaction of people. Artifacts like IT represent forces of behavior rather than determinants of behavior. These artifacts are negotiated and socially constructed, resulting from the exercise of power, reification, and institutionalization of certain views of the organizational reality. From this viewpoint, the organizational structure is inevitably emergent because it is always in a state of change. Virtual organizations do not alter the essence of this process, but use new mental models and IT to accelerate the speed with which the human organizational structure emerges. Virtual organizations adapt more quickly to their surroundings because the social negotiation process is faster. Virtual organizations are different because they change rapidly. Virtuality is about speed.

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Virtual Organization: The Simple Way to Add Value to Complex, Distributed Processes

Witold Abramowicz

Abstract

Market competition forces enterprises to change their operating procedures. Software distribution is an example used in demonstrating these changes. The process of software distribution may be controlled by a workflow. The Workflow Management Cycle can be used within a number of various co-operating enterprises employing distributed workflow management. This process may also be implemented on the basis of the virtual organization concept. During its implementation, the main problems requiring solution are caused by reasons unrelated to the IT technology itself.

1 Changes in business

Competition demands a shortening of the development cycle, the improvement of technology and a lowering of costs. This necessitates the introduction of several organizational changes in business: the leveling and simplification of organizational structure; orientation towards the performance of actions according to priority, rather than the order of their creation; concentration on the goal of the given business thanks to the extension of cooperative relationships; the ability to create products giving a desired level of quality (within acceptable parameters); the creation of mass products for consumers, as custom made ones created individually with their specific needs in mind; individualization of working conditions.

Information systems may support such processes. However, the means of reaching the requested changes is through the virtual corporation.

2. Case study - software distribution

The modern way of distributing software consists of following stages:

- The dealer sells the software to the end user.
- The dealer buys the software from the distributor.
- The distributor obtains the software from the software manufacturer.

Today, software producers usually sell their products in many countries. A distributor may provide information about a particular market, limited by a geographical area (e.g., a country) or by an application area (e.g., database management systems for financial institutes). The dealer has knowledge not only about the market but also about particular customers belonging to this market. In this way he is adding value to a standard software package.

This, however, is no longer enough, as a customer does not look for software but for solutions to the problems. For example, if a customer buys a package to support a business organization, he expects that the system will be able to process data in three different ways: in a way, which conforms to the local legal regulations; in a way common to all enterprises in a particular industrial branch (not necessarily limited to a single country); in a way, supporting brand and product differentiation and providing an advantage over competitors.

Thus, to satisfy the end user's requirements, it is necessary to add value to a standard software package including competence in three areas of information processing (as mentioned above), training, logistics of the IT delivery system, financial service, development, delivery and production support of the technical and organizational infrastructure requested by the IT solution.

According to current impressions, E-commerce is not the way to eliminate any of the above elements from the manufacturer, distributor, dealer, end-user chain. Each of them has to form alliances, in order to be able to realize a given order.

3. Solution - workflow for virtual space

hour example (Fig. 1), the classical workflow management cycle has to be distributed over a number of companies forming a chain. Our example is not an exception. Similar chains exist in areas like: building construction, travel agencies, electronic industry etc.

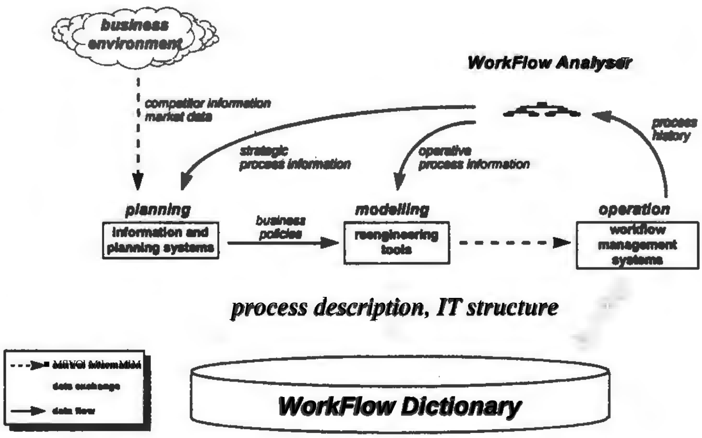

Fig 1 Structure of the Workflow Management Cycle [2]

Thus, it is necessary to enhance all forms of the virtual organization: the virtual workplace, virtual team and virtual enterprise [1]. The virtual workplace can be applied to examine all options to satisfy an end user's needs in the example shown above. The virtual team will ensure that an end user's needs are satisfied by all members in the chain: manufacturer, distributor, dealer and end user. In the end stage, the virtual enterprise is the way to create an enterprise that satisfies the requirements for any particular end user, and is also a proposal addressed to new end users having similar needs. Simultaneously, this creates a distributed workflow management. Fig 2 shows the dimensions of a distributed workflow management.

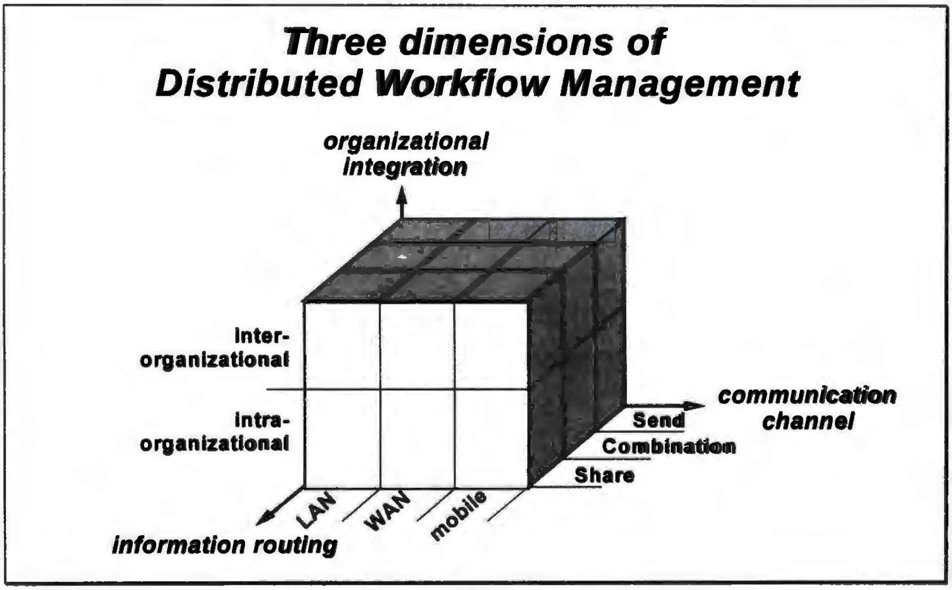

Fig 2 Dimensions of distributed workflow management [3]

The experience gathered from the projects performed within my department shows that the distributed workflow management may support implementation of changes proposed in Section 1. My experience shows that it is not IT technology that is the barrier to virtual organization, but rather: a lack of domestic and international legal regulations, e.g., for the international acceptance of electronic documents and electronic signatures; trading risk in global networks; a lack of universally applicable norms for work habits and organization; and the problem of still existing language barriers.

It is my belief that the virtual organization will see widespread use, if only the problems currently occurring outside of IT technology will first be solved.

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Virtual Organizations: A Challenge for Interdisciplinary Research

Guenter Haring

Abstract

The literature on business management offers a wide variety of definitions for „organization" [1]. Common to these definitions is that organizations are seen as groups of people working together for common (corporate) goals, using available means, like resources, skills, knowledge, etc., in any available and appropriate form. Beside the goal orientation the social composition and behavioral structure are the basic factors of an organization, which are to guarantee effective and efficient fulfillment of the goals.

The seperation between corporate goals and means to reach the goal, corresponds to the generic architecture of information management systems. A systems view, focussing on the dynamic nature represents an organization as an open system, which receives input from the environment and returns output to the environment. Organizations incorporate and use basic services, like communication, cooperation and coordination services as well as information sharing to optimize the mean-goal mapping, i. e. to realize the input-output-transformation process. As with natural and programming languages where we know that the features and characteristics of the language determine the way how to think and how to solve problems, the features of the basic services determine how to reach the goals most efficiently.

So far there is nothing new. Today corporations are confronted with a faster and faster changing enviroinment both at the input and at the output side. The input side is characterized by shorter technological cycles, new paradigma, like World Wide Web and Java, as well as evolving integrated collaborative environments (ICE) and new, cheap labour markets.

On the output side new challenges are arising at the horizon according to volatile customer behavior, new customer requirements, new forms of trading, new markets, etc. The corporation has to react to the changing environments appropriately by adapting its organizational behavior in according terms.

Here the concept of virtuality comes into the game. According to Turoff [2] „virtuality is the property of a computer system with the potential for enabling a virtual system (operating inside the

(computer) to become a real system by encouraging the real world to behave according to the template dictated by the virtual system". Thus virtuality offers the potential to generate new organizational structures with different instantiations, in a flexible, dynamic and fast way.

Virtual organizations are to bridge the gap between dynamically changing goals and means efficiently. Switching organizational structures and behavior - using (web-based) ICE-technology - will become a basic management principle.

The basic concept of virtual organizations is completely open with respect to control structure and spatial as well as functional distribution.

Right now we have a vague understanding of what a virtual organization could be. Much vaguer is our understanding of its basic principles and how it works or how it can be implemented.

There is a lot of open questions:How does management science change? Is the theory of adaptive organizations sufficient? What are the requirements at the layer of basic services? How are ICE-technologies to be designed to support the concept of virtual organizations optimally? What techniques of operations research are appropriate to guarantee longterm efficiency of the goal-means mapping? What about the cost-profit-ratio of the switching principle? Where are the (economical/behavioral) limits of virtual organizations?

These and more open questions, which are not independent from each other, ask for a interdisciplinary research on this topic, including at least computer science, management (including social) science and operations research. A wide variety of applications is available as environments for field tests.

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Virtual Organisations: Are they temporary or permanent?

Wolfgang Jankó

There is more research, more progress and more change than ever in the world today. The num[illegible] of significant news per unit of calender time increases and so does social and economic chang[illegible] Despite this fact we live in a time where the average life expectancy is longer than ever and the [illegible] economic wealth is higher than ever, but the subjective degree of satisfaction seems to be lower [illegible] the forecastability of the development of society and economy gets shorter. The organisations rea[illegible] to this increased necessity to adapt their structures to the ever changing environment with a new flexibility. This new flexibility is very much supported by tools of information technology like EDI, telecommunication and international networks and information systems. As an accepted clea[illegible] definition of the virtual enterprise is missing, we observe various patterns of appear[illegible] However, it seems to be accepted that virtual enterprises are legally independent enterpri[illegible] institutions or even single persons which produce a product based on common business ideas. The incorporated units contribute by their core competences mainly and appear as a sole enterpri[illegible] third parties. Instead of having institutionalized central management functions to design, ma[illegible] and develop virtual enterprises they use information and communication technologies. There [illegible] different development steps to a virtual enterprise. In the final step, an information [illegible] coordinates the activities between various enterprises which contribute to the product. By select[illegible] the elements in this cooperation the virtual information broker is able to react much faster to [illegible] changing environment and competition compared to an institutionalized organisation.

The information systems and information and communication technologies play an essential role [illegible] virtual enterprises. The more standardized these information management tools are, the faster [illegible] virtual enterprise is able to adapt itself and speed up the organisational learning process. We [illegible] observe many appearances of virtual enterprises in each development stage but it is yet to be seen [illegible] if not new types of the institutional enterprise will be formed, that are able to better support [illegible] business idea of a virtual enterprise: the virtual broker and the virtual infrastructure provi[illegible] Enterprise modeling software developers like SAP, BAAN, Peoplesoft and others are increasingly [illegible] buying or incorporating consulting companies and are increasingly using standardized interfac[illegible] Their systems are more and more able to work with competing systems. Contributing thus to [illegible] continuous reduction of transaction costs the possibility of the installation of a new business id[illegible] using modern telecommunication and enterprise software becomes cheaper and easier. It remains [illegible] be seen if in successful virtual enterprises with the decrease of competition in the market seg[illegible] of cooperating partners these enterprises will not finally end in an institutional enterpri[illegible] competition is high, product and product parts are highly standardized the change of coop[illegible] partners is a necessity for staying alive. The higher the competition, the easier the change, the [illegible] has advantages the virtual enterprise "construction". This will induce a considerable amount [illegible] pressure on information system developing companies and on the telecommunication indust[illegible] However, the future will show if virtual enterprise is only a temporary form in a massiv[illegible] changing market place used to overcome temporary institutional immobility or if they will b[illegible] permanent in every industry as a reaction to the decrease in transaction costs and an incre[illegible] structural and social change induced by the fast progress of science.

Panel

Virtual Enterprising – The Way to Global Manufacturing

Luis M. Camarinha-Mathos (Chair)

Peter Bertok

Josef Küng

Jiri Lazansky

István Mezgár

Masashi Shinonome

VIRTUAL ENTERPRISING:
THE WAY TO GLOBAL MANUFACTURING AND ITS CHALLENGES

Luis M. Camarinha-Matos[1]

Abstract

The concept of virtual organization and in particular its application to associations of collaborating industrial companies, forming virtual enterprises, represents an important new approach to the way industrial manufacturing is organized worldwide. Although the basic enabling technologies are becoming mature, there are still a large number of challenges to face before the potential of this paradigm can be materialized. This position paper enumerates some of these challenges, considering the various phases of the life cycle of a virtual enterprise, which represent open areas for further research and development.

1. Introduction

Definition and motivation. The paradigm of virtual enterprise (VE), as a temporary alliance of enterprises that come together to share skills and resources in order to better respond to business opportunities and whose cooperation is supported by computer networks, challenges the way manufacturing systems are planned and managed. Companies, specially the Small and Medium Enterprises (SMEs) must join skills and resources in order to survive and gain competitive advantage in a global market environment. The materialization of this paradigm, although enabled by recent developments in communication technologies, computer networks, and logistics requires the definition of a reference architecture for cooperation and the development of a flexible supporting platform and appropriate protocols and mechanisms [2], [6].

The research area of VE represents a complex, large scale and multidisciplinary domain. The cooperation scenario in VEs involves distributed, heterogeneous, and autonomous agents (both software and people).

Classes of VEs. There are a large number of networked organizations of enterprises that fall under the general definition of VE and which require a diversified panoply of supporting functionalities. A first basic classification according to a number of characteristics such as duration, topology, coordination, and visibility scope, has been introduced in [2] and [3]:

- Duration. Some enterprise alliances are made for a single business opportunity and are dissolved at the end of such process. This situation corresponds perhaps to the most typical kind of virtual enterprise for which examples can be found in large scale engineering systems, such as, for instance, consortia involved in building a bridge or a railway. But there are also long term alliances that last for an indefinite number of business processes or for a specified time span. In most cases of supply chains in food industry or in the automotive industry it is more common to find long term alliances.

- Topology. According to the topology of the network, there are situations that show a variable / dynamic nature, in which some enterprises (non strategic partners) can dynamically join or leave the alliance according to the phases of the business process or other market factors. But in many

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sectors there are supply chains with an almost fixed structure (little variation in terms of suppliers or clients). The case of dynamic (volatile) topologies, may require specific functionalities for partners (suppliers and service providers) search and selection, maintenance of suppliers directories, and support for the partners joining / leaving actions. Another aspect to be considered is the interaction with other enterprises that do not belong to the VE, such as the occasional suppliers or the spontaneous clients (perhaps through the electronic commerce).

-Participation. Another facet to be considered is the possibility of either an enterprise participating simultaneously in various networks, or being dedicated to a single one (exclusivity). In the non-exclusive case, it is necessary to handle various virtual participation spaces and following different cooperation rules.

-Coordination. In terms of the network coordination, various models can be found. In some sectors, as typified by the automobile industry, there is a dominant company "surrounded" by a relatively fixed network of suppliers (star-like structure). The dominant company defines "the rules of the game" and imposes its own standards, namely in terms of information exchange and access rights, on others. The concept of extended enterprise can be used to describe this particular case, as it represents a dominant enterprise extending its borders over the satellite suppliers and service providers. A different organization can be found in some supply chains without a dominant company (democratic alliance) in which all the nodes cooperate on an equal basis, keeping their autonomy, but joining their core competencies. But even in this case, a coordinator node may be necessary in order to keep the general information regarding the VE membership, and to monitor the organizational structure and cooperation principles. In some other cases, once a successful alliance is formed, companies may realize the mutual benefit of joint management of resources and skills and they may tend to create a kind of common coordination structure (federation). There are less real life examples of such federated structures except in the cases of groups owned by the same holding, but it will not be surprising if the market dynamics forces SMEs to embark in such deeper coordination alliances.

-Visibility scope. Both related to the topology and coordination is the aspect of visibility scope, i.e., "how far", along the network, can one node "see". In most cases a node only sees its direct neighbors (suppliers, clients). That is the case observed in most supply chains. In more advanced coordination situations however, a node might have some visibility over other (non-direct) levels, including some levels of information access, which may lead to a more optimized operation of the VE. Order fulfillment monitoring, planning, scheduling and rescheduling, work load distribution, and optimized resources management are examples of advanced coordination tasks that require an extensive visibility scope.

Need for flexibility. In terms of the coordination models and behavior of supporting platforms for a VE, there are a large number of factors that impose a flexible approach. Examples of such factors are:

- -Diversity of roles played by each enterprise, such as VE member, coordinator, client, supplier.
- -Diversity of internal management policies and socio-organizational structures found in each company.
- -Diversity of VE classes, in terms of duration, topology, coordination policy, visibility scope, etc.
- -Diversity of rights and duties that can be associated to each VE member.
- -Diversity of contract / subcontract forms.
- -Participation of a company in multiple VEs.
- -Evolution of supporting technologies, safety mechanisms and the legal framework for electronic commerce.

Besides these factors, it shall be noted that forms of interaction and cooperation between enterprises are likely to evolve with experience and trust building mechanisms.

International projects. Several international research projects address various aspects of the VE requirements. Examples of such projects are:

- NIIIP Program: LITE, SMART, SHIP, AMMPLE, SPARS.
- IMS Program: Globeman 21, MISSION, etc.
- ESPRIT Program: VEGA, PRODNET II, MARVEL OUS, TEMPO, TOCEE, X-CITTIC, PLENT, etc.
- INCO & ALFA Programs: MASSYVE, COSME-GVE, SCM+, etc.

In spite of the efforts being put in this area, the current approaches and prototypes are quite limited, still lacking a comprehensive and flexible characterization of the multiplicity and variety of the cooperation scenarios.

In the following sections some of the open issues for the various phases of the life cycle of a VE are suggested.

2 Creation of a VE

The consortium formation is mainly an activity carried on by humans and, therefore, most projects concentrate on the operational phase of a VE. However, some tools might be helpful in the creation phase.

Partners search and selection. Although the list of usual suppliers is normally a private asset of companies, for occasional suppliers it may be necessary to resort to some general partners search and selection functionality. Many organizations are offering directory services assisted by dedicated search engines. Several difficulties can, however, be found in these services: (i) Each directory has its own structure, which is an obstacle for a generic search profile definition. The adoption of the UNIDO industry sectors classification could be a good start. (ii) The way these search engines accept queries also needs normalization. (iii) In their current version, most of these systems are designed to interact with human clients and give results in non-normalized HTML pages. This is an obstacle to semi-automatic partners search mechanisms. The interaction between these engines and software agents is a possible tendency that also requires standardization of protocols. Negotiation mechanisms can also be developed in association to partners search for an interactive selection process.

Contracts. Contracts regulating the relationships between enterprises usualy specify duties in terms of information exchange. For instance, a company may be obliged, by contract, to periodically supply its client with information about its orders status. Some of the rules and workflow plans that regulate the behavior of a VE can be derived from these contacts but this would require a normalization of the contracts structure. Furthermore, the development of VE contracts management systems seems to be necessary.

Configuration is an important step when launching a VE. This configuration will involve definition of the VE structure (members, coordinator, topology), roles, rights and duties, as well as the local and global behavior.

Implantation methodology. As a VE is usually formed by pre-existing enterprises, the implantation process shall minimize the impacts on the operation of these companies and allow a smooth step-by-step introduction. The development of appropriate implantation methodologies is necessary.

Socio-organizational issues. Besides the technological aspects it is very important to identify the VE consequences in terms of the working structure, the processes, and also the roles played by all social intervening actors. SMEs are, in many cases, characterized by a strong human-centred decision making philosophy, and strong feelings for autonomy and information privacy. The VE paradigm requires the acquisition of a new culture, the willingness to share and trust, and a new idea of ownership that goes beyond the borders of each contributing node. Some new organizational architectures are expected to be established, which makes it necessary to determine and plan for the necessary changes in the roles and skills of the human operators.

3. Operation of a VE

During the operational phase of a VE, some of the issues to be considered are:

Information interchange. This is the starting point for any platform supporting a VE. Some general classes of information are well identified and usually considered by most projects, such as business (orders-related) information or technical product data. A less clarified aspect is the timing and who takes the initiative of such information exchanges. Although the basic interactions are asynchronous, started mostly by the "client", there is also a need for exchanges based on periodic or pre-defined conditions (a kind of push approach). In addition to this, "tele-monitoring" support is also becoming important in subcontract relationships. The contracter wants to "inspect" the progress of its order. The federated database management paradigm a promising approach to deal with these requirements [1]. Another aspect deserving more attention is the exchange of information related to quality management. The ISO 9000 series specifies a set of regulations for each company but the quality information interactions on a supply chain are not so clear. Current regulations on the responsibility for the quality of a product that includes parts manufactured by different suppliers also reinforce the importance of this topic.

Business process coordination. Assuming that a high level of trust and cooperation can be achieved in a VE, a distributed business processes modeling and management is necessary. Examples of questions at this level are: How to define VE goals? How much of the decision making process (nowadays handled by individual PPC systems) should be moved to a global coordination ("federal government")? How to distribute the workload and define dynamic and distributed schedules?

Workflow management. Several projects have pointed out the usefulness of a workflow management approach for coordinating activities in a VE. The adoption of the reference model proposed by the Workflow Management Coalition seems to be a major tendency [7]. There is however a need for defining hierarchical coordination architectures and the interaction forms between the various workflow engines and the other software systems such as PPC, EDI, etc.

Supporting logistics. Being logistics a key factor in the operation of an industrial virtual enterprise, a more close integration of developments between the area of logistics and the VE supporting platform is necessary.

Legal framework. The legal framework for contracts / business transactions performed via the network needs to be defined [5]. This problem is shared with the area of Electronic Commerce.

Collaborative / Concurrent engineering. Most of the work done on collaborative engineering is directed to the context of a single enterprise. Joint workspaces implementing appropriate safety mechanisms, specific workflow models and collaborative protocols are necessary for collaborating teams involving participants from different nodes of the VE. The federated database management approach may offer adequate support for the information sharing / joint workspaces. Advanced/distributed workflow models and multiagent protocols have to be developed to support cooperation.

Tele-operation and tele-maintenance. Sharing resources and skills may lead to scenarios where companies may have (limited) remote access to the shop floor of their partners in order to monitor the evolution of some task / process, or even to tele-operate some devices in cooperation with the local operators. Efficient multi-media information exchange, safety mechanisms, adaptable mobile agents, etc, are examples of supporting areas to be further developed.

4 Dissolution of a VE

When the objective that motivated the creation of a VE is achieved (or lost its validity) the VE dissolves itself. This process also needs to be better understood and supported by adequate tools. Some of the aspects to be considered are:

Information management aspects. When the VE ends, it is necessary to decide what to do with the "common heritage" in terms of information repositories, historic records for any future tracing operation, etc. It is also necessary to offer the member companies the configuration mechanisms to cease the special access privileges granted to their partners during the VE operation.

Liabilities. A careful assessment of responsibilities, according to the cooperation contracts, has to be made when the cooperation reaches its end.

Exclusion of a partner. Similar questions may be raised in the case of VEs with a dynamic composition when one partner leaves the consortium.

5 Infrastructure to support a VE

Basic infrastructure and standards. Most running projects are aiming the development of middleware infrastructures to support safe interchange and sharing of information. The adoption of standards, like EDIFACT and STEP, represents a common practice, but for some classes of information (quality-related information, logistics and distributed business process management, electronic catalogs of products / services, etc.) there aren't standards or common tendencies. In terms of safety, privacy and authentication, most of the cryptography and digital signature methods being developed by the Electronic Commerce community may be used by VEs, but the situation is not stable yet. The current attractiveness of Internet, due to its low cost and friendly tools, by opposition to VANs, raises the importance of the safe communication issues. The relatively low reliability of the network, the possibility of some nodes being temporarily unavailable, and the poor response times, also call for different strategies in terms of distributed information management architectures.

For specialized market niches ("closed universes") special agreements between partners may cope for this lack of standards. That is also the case of VEs with a dominant company (e.g. automotive sector) that imposes its own rules. However, for scenarios where companies may be involved in multiple VEs, with a high volatility, i.e. short term VEs ("open universes"), it is crucial to converge to a well established and standardized infrastructure. The USA approach to define a national infrastructure (NIIIP program [4]) seems more consistent (although too biased by the American reality) than the European strategy. In the EU case, the approach is more fragmented. Many projects are attempting to define their own infrastructures without any convergence effort towards an European infrastructure. As a VE may, in principle, involve companies in any continent, a real global "standardization" effort seems necessary. However, the normal "official" standardization mechanisms do not seem to be able to give timely answer to the problem.

Reengineering. Methodologies for reengineering of legacy systems and implantation methods are one of the most difficult tasks, necessary for the successful formation of VEs. A major example is the reengineering of the PPC system which may involve:

- Extensions to the functionalities of the PPC, such as the functions to answer requests coming from the network (e.g., requests about orders status or quality related information). Traditional PPC systems are designed to interact with human operators rather then with software "clients".

- Mappings between the PPC internal data models and the data structures handled by the cooperation infrastructure (namely EDI, STEP, etc.).

- Integration of the internal and the VE-related decision making: workload distribution, production planning, partners search and selection, etc.

Similar changes may be necessary for other legacy systems.

6. Conclusions

The development of the VE paradigm and its supporting infrastructure represent an important opportunity, but also a major challenge, to the manufacturing enterprises worldwide.

The basic supporting technologies are becoming available but there is a need for the definition of a flexible reference architecture able to cope with the diversified requirements of the various types of virtual enterprises. Configurability, openness and safety are major requirements.

In order to achieve affordable solutions, a concerted effort for the definition of a minimal standard infrastructure is necessary. Such "standard infrastructure" is a survival factor for the SMEs and the only economic solution for highly volatile organizations.

Apart from the basic infrastructure, there are a large number of other challenges – technical but also legal and socio-organizational – in order to support the various aspects of the life cycle of a VE, that remain as open issues requiring further research.

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FRAMEWORKS FOR VIRTUAL ENTERPRISES

Peter Bertok[1]

1 Introduction

1.1 Virtual Enterprises

A virtual enterprise is a temporary alliance of companies for the lifetime of a common project, of the solution of a problem, or of joint development of a service or product. The idea of virtual organisations is not new, but the lack of efficient cooperation tools was a significant obstacle in their development until very recently. It was the proliferation and pervasiveness of the Internet, and most importantly the World-wide Web, that enabled and produced a new generation of virtual enterprises. [5]

1.2 Key Problems in Virtual Enterprises

A virtual enterprise may include different organisations at different locations, possibly in different cities, countries or continents. The participating organisations may have different management structures, may use different technologies in similar applications, and may have several other differences. The cooperation of different tools and methods poses a difficult challenge.

The new virtual enterprises heavily rely on communication and sharing of distant / distributed resources, which may be intra- or intercompany resources. The status of these resources may change during the lifetime of the virtual organisation, resources internal to a company may become public within the virtual organisation, and sharing of certain resources may have to be withdrawn at any point in time. Programs, tools and utilities that facilitate resource sharing, communication and cooperation are appearing in increasing numbers, but in most of the cases they are not compatible, and may not even be able to communicate or cooperate with each other. Even open systems need tailoring to meet individual requirements.

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2. Solutions

2.1 Standardisation of technologies

Standardisation may overcome the difficulties of heterogeneity, but it has several major disadvantages, making it unsuitable for virtual enterprises. First, the effort of installing a uniform system throughout the virtual enterprise is difficult to justify, in particular, when considering the relatively short lifetime of a virtual enterprise. Also, installing such a system may require an excessive amount of time, which then will threaten the success of the whole mission. Other disadvantages include the difficulty of including latest developments and the lack of flexibility.

2.2 Frameworks

The relatively short lifetime of virtual enterprises requires the use/reuse of well proven techniques, existing solutions, components and patterns as much as possible. *Reusability* means that those components, solutions etc. have to be developed in a methodical, efficient and well-organised way. Support is also needed to connect the different parts in the new system efficiently. Application frameworks can have an important role in this process: they can combine and connect existing modules to suit the application, and provide templates for new modules. In short, they support reuse in a systematic way and reduce the time needed for installing a new system. There are many definitions of what a framework is, e.g. a framework is "a reusable design of a system", "a skeleton that can be customised by the system developer" [4], or "a generic application that allows the creation of a specific application" [6], which all describe the essence of the framework approach.

The *design* of a framework, however, is becoming a challenge. If the framework is too general, then adapting it to a specific scenario may need excessive efforts. If, on the other hand, the framework is too specific, it may not be suitable to the new application in every aspect. To find the balance is a cardinal issue in framework design, and this often translates to establishing a structure and providing mechanisms for adaptability. The structure is usually rigid and difficult to modify, so flexibility is introduced by additional means: a set of plug-ins, or at least plug-in places called hot spots, cater for variability and enable the tailoring to individual applications.

Based on their scope and intended application area, frameworks can be *classified* as system infrastructure frameworks, middleware integration frameworks or enterprise application frameworks [3]. System infrastructure frameworks, such as user interfaces or tools/ environments for processing, manufacturing etc., are mainly used within particular development organisation, and are not readily available for customers. Enterprise integration frameworks represent the other end of the scale, with expensive components, large complexity, and supporting the end-user directly. In between are middleware integration frameworks that have several advantages, namely they can bring together application experts and system developers, they are not too complex, and are close enough to and well understood by the end-user. While middleware integration frameworks are developing at a very fast rate, these frameworks have not yet fully exploited the possibilities of providing a bridge between system development and application. In particular, the potential of integrating different components has not been investigated and utilised thoroughly.

3. Application Frameworks for Computer Integrated Manufacturing

Virtual enterprises are often related to manufacturing, and the key virtual enterprise features of short running times and flexibility motivated the development of several CIM frameworks. The complexity of manufacturing processes to be controlled, the large size of the software required, and standardisation lagging behind, all contributed to the development of CIM frameworks, such as Sematech [1], Smart Fabrication/Project CIM [2]. These frameworks provide a class model (structure) and variability tools through plug-in places for application specific components. The main modules can be selected from a set and linked together according to the applications' needs.

Frameworks require the cooperation of many modules, and the modules are autonomous in order to avoid unnecessary cross-dependencies. In Sematech, the common components cooperate through the object request broker (CORBA), and the different application specific objects are plugged to the common modules.

4. Conclusion

The short lifetime of virtual enterprises necessitates an infrastructure that can be set up quickly and easily. Frameworks, with reusable components, patterns and solutions can facilitate the development of information infrastructure of individual virtual enterprises. There are already existing frameworks for the manufacturing arena, but general frameworks are not yet available.

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USER EXPERIENCES WITH TELEMATIC TOOLS IN A VIRTUAL ORGANISATION

Josef Küng[1]

1. Introduction

Computer networks allow companies to collaborate electronically. Products that might not be, feasible for companies to be produced individually become feasible when the same companies share data and technology, an arrangement we call an industrial virtual enterprise. Virtual enterprise share costs, skills, and core competencies that enable them to access global markets collectively. The important thing is that each participant brings in his key competence to build a virtual 'best-of-everything' organisation.

Technology is a crucial part of the virtual organisation. Partners want to use tools to keep in touch with work forces that operate throughout the world, both within and outside the company's boundaries. Voice-mail, e-mail, video conferencing and intranets are today's commonly accepted tools, saving travel time and expenses. But, are the existing tools feasible enough?

2. Experiences from the Teleregions SUN Project

Since three years our institute is involved in a project called Teleregions SUN which is part of the European telematic programme. This virtual organisation between about 70 companies and adminstrations has the goal to build a fully fledged regional and trans-national model for matching regional development needs to integrated telematics investment programmes.

Our task was to set up and maintain the necessary commimication infrastructure. The basic communication system consists of several modules. By means of this modules each partner of the project is able to access the project related document libraries located on several region specific servers all around Europe. Some additional mechanisms were implemented on top of these servers to support partners in finding project information: Each document in one of the regional

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servers can be registered in a central project database, which is available for all partners. Furthermore a tool supporting co-operative work via internet and WWW has been installed and tested with regard to project benefit.

In the first phase of this project a general inquiry by questionnaires within the users was made to collect and analyse the user needs. The result has shown that everyone was enthusiastic about all features, technology made available and wanted to use it. But, after all the evaluation showed, e-mail was used only, sometimes ftp. A second inquiry done by expert interviews indicated the reasons. First, there were the low transfer rates, especially in regions with less communication infrastructure. Second, the software tools had some shortcomings. But, the main reason was that the tools were not integrated in the daily workflows. In particular the algorithms in the users mind did not consider the new possibilities. For instance, to find a partner's address the calling card box was used, not the partner database.

This year the situation has changed significantly. E-mail goes without saying, but ftp seems to be out. However, the most interesting thing is that the users want to have an internet browser as the only interface to the virtual organisation. Since security is very important, a private virtual net for the virtual organisation is required. The third tool accepted besides e-mail and internet browsers is video conferencing. Many of the project members use this tool to save time and money. And the fourth trend we have encountered are groupware tools. Groupware tools are already getting a mature technology and are now suitable for virtual organisations.

3. Conclusion

User acceptance of telematic tools has increased rapidly within the last few years. In spite of these encouraging facts that the existing tools support virtual organisations quite well there are still some lacks, in particular concerning integration aspects. There seems to be a barrier between tools supporting the tasks within the traditional organisation, especially legacy systems and the technological equipment for virtual organisations. Redundant data along with all its disadvantages as well as redundant work is the consequence. In this area research and development work will be necessary.

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MULTI-AGENT SYSTEMS FOR VIRTUAL ENTERPRISE

Jiří Lažanský [1])

Abstract

This short paper expresses the author's position for IFIP World Congress Panel Discussion Virtual Enterprises. The position paper concentrates on analogies between multi-agent systems virtual enterprises, and on open problems of multi-agent systems.

1. The Concepts

The generally accepted meaning of the term *Virtual Enterprise* (VE) is at least twofold. (1) T *business-oriented meaning* of this term represents an organisational structure of a develop manufacturing, and servicing enterprise that is split into several tightly co-operating units with al managerial hierarchy compared to the hierarchy necessary in a single large company accompli the same tasks. Thus the VE is potentially more efficient thanks to large savings in the managem (2) The *information processing view* of the same concept is much more diverse and general. It considered as the information and decision support for the business-oriented VE since only efficient co-operation among those stand-alone units can achieve desired efficiency. How information processing plays an important role in a classical enterprise, especially when consid a large enterprise with world-wide distributed divisions.

Probably, the most suitable connecting link of the just mentioned two meanings of the VE is concept of *multi-agency* and *multi-agent systems* (MAS). Again, the term of MAS needs so clarification as many authors use this phrase in very different contexts. At the Czech Tech University, we understand MAS as a set of pro-actively co-operating autonomous software u (agents) that run usually on networked computers. One of the main problems of MAS is th efficiency that can be lost due to excessive communication among the agents. The m distinguishing feature of the co-operation within the MAS is a sort of *willingness* of the indivi agents to work hard on the joint goal.

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2. The Analogy

Every agent in a MAS can represent a manufacturing and/or service unit within the VE. One of the main goals of a VE is to achieve high overall efficiency at the lowest possible cost. The original idea of the VE is to reduce the management expenses. When comparing the VE structure with MAS, the similar situation arises in MAS: no central agent of the MAS is expected to exist with the goal to enhance reliability and to reduce communication (cost). It also means that no centre dictates the global goal. The MAS try to solve this problem by equipping each agent by a set of dynamically maintained data and knowledge bases that contain information on other agents within the community. The are several ways how to keep that information fresh, all of them being based on so called *acquaintance model* [1]. Appropriate parts of these models serve as a distributed specification of the community's global goal.

Practical usefulness of MAS has been demonstrated within a EUREKA project [2] for production planning in a project driven manufacturing. Experiments have shown that the extremely difficult task of planning and scheduling in the enterprise can be replaced, to a high degree, by negotiation among agents each of which represents a particular part of the company (design department, purchasing, workshops, etc.). Again, the principle is similar to the standard situation in human society where people co-operate in time without having a central planning unit that schedules what and when to ask others for task sharing[2].

3. Tasks for near future

Many problems of MAS are subject of future research to achieve reliability and versatility of the MAS approach. Diverse ideas to fulfil those goals have been proposed recently. A commonly accepted *language for inter-agent communication* of data, knowledge sharing, and task distribution is still missing. Suitable *tools for design* of practically applicable MAS do not exist. The concept of multi-agency is considered to be a good means for *integration of legacy systems*; nevertheless no standards for incorporation of existing programs into an agent community exist. However, probably the most difficult task of the ongoing research (event from a philosophic point of view) is the *implementation of* real *pro-activity* so that the software agents will co-operate efficiently.

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2 We in the Central and Eastern Europe have much experience with the attempts for central planning.

Communication infrastructures for virtual enterprises

István Mezgár[1]

1. Introduction

Improving quality, productivity and time-to-market can make the difference between success and failure in today's competitive global marketplace. In order to keep their positions manufacturing enterprises have a strong motivation to move from large, hierarchical organisations to small, decentralised, partly autonomous and co-operative manufacturing units, which can respond quickly to the demands of the customer-driven market.

These new characteristics of production systems is realized in new organisational structures (loosely coupled autonomous production units), in new information architectures and communication infrastructures as well. If some of the autonomous production units form a temporary co-ordinated network for production communicating via computer network (e.g. via Internet), this organisational form can be called as "virtual enterprise" (VE) or "extended enterprise". In the practice there are two main ways to form a VE; decompose a large company into smaller units, or aggregate little firms (e.g. SMEs) into the form of a VE.

The virtual enterprises formed by these two approaches have different requirements as both the inherited characteristics and the goals of the original manufacturing units are very different. The common requirements of environmental factors that make possible the VE realisation are the fast transport and communication means, and the spread of principles, know-how, and business practice to all enterprises in the virtual enterprise.

The main factors that describe the characteristics of a VE are the basis of fast reaction, the types of system organisation, the duration of aggregation and the way of network co-ordination.

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2 Integration and communication

The information technology has a central role in the virtual enterprise. With the tools of information technology both the product and enterprise can be described in the form of models, so in this way the information technology can be the base for integrating the different fields. There are various approaches to integration in the world of products and enterprises but the goal of all types/forms of integration is to reduce data conversion, that means reduction of communication time, increase data/information/knowledge exchange/sharing (communication) reliability. In the field of enterprise integration there are three levels as defined in AMICE Esprit project; *Physical, or system integration* - integration aspects: basic computer communication, message passing, and interconnection (technologies; OMG/CORBA, TCP/IP, Internet/WWW, etc.), *Application integration* - integration aspects: distributed co-operative applications, data/information exchange, and application interoperatibility (technologies: EDIFACT, STEP/PDES, KIF/KQML, HTML, etc.) *Business integration* - integration aspects: business process co-ordination, enterprise-wide knowledge sharing, interworking (technologies: CIMOSA, GERAM, ENV 40003, etc.).

The standardisation always has an important role in connecting/integrating different information systems in which the models are represented. The standards (or pre-standards) applied in VE can be grouped into data (e.g. product - STEP, commercial - EDIFACT), process (workflow - WPDL, process – PIF), and knowledge (e.g. KIF) related descriptions.

3 Technologies for VE

There are three main fields of technologies that make possible to establish and operate a virtual enterprise; *Co-operative management of VE projects and tasks* – (Effective workflow- and business process management is essential in virtual enterprises), *Information modelling an exchange* – (The different information models (product-, enterprise-, etc.) and the standards provide the basis for communicating the information at all stages in the product and enterprise life cycle), *Communication tools and standards* – (A VE by its very nature is distributed. The product and process information, communication happens by means of computer networks).

4. Communication in virtual enterprises

According to the enterprise integration architectures the communication is on the basic level of the hierarchy. The communication infrastructures can be based on Internet or on various VAN solutions. The client-server approach is the base of the network and in the implementation CORBA is applied in most of the cases. The Internet TCP/IP is required for transporting CORBA GIOP, but DCE maybe also used with ESIOP transport giving access to its different services (e.g. security). The WWW infrastructure has an increasing role too, as it offeres very dynamic information access.

Security is an important aspect in VE communication during operation as valuable product and production information are exchanged in the network. The basic security requirements for VE communication are the confidentality, the integrity and the authenticity. These requirements can be realised in different layers e.g. on protocol-, OMG-, and application level.

In order to describe the flow of comunication in the VE a network model has to be developed. The key element of this model is a coordinator-type unit that controls the communication of the different units/elements of VE according to the pre-defined strategies and rules (e.g. as realised in PLENT and PRODNET ESPRIT projects).

The National Industrial Information Infrastructure Protocols (NIIIP) project initialised by the NSF is the most complete realization of a VE architecture. It intends to bring together the product realization process integration efforts, by developing general global protocols for the technical standards of product data definition, communication, object technology and workflow management. The NIIIP doesn't intend to develop a new system, rather applying existing standards to consolidate, harmonise, and integrate the many sets of existing protocols.

5. Conclusions

The continuos, coordinated and structured communication is the basic characteristics of virtual enterprises as the operation of VE is based on permanent change, on adaptation to orders. In order to give the possibility for every firm that intends to join to a virtual enterprise, VEs have to be based on the internet, and special information and communication architectures have to be developed parallel, that apply the existing standards of the fields in a consequent way.

VRIDGE Demonstrator of Globeman 21 project

Masashi Shinonome

Abstract

This paper presents the design of a typical virtual enterprise (VRIDGE Inc.) as well as an integrated software environment for supporting the design, implementation and operation of the virtual enterprise (VRIDGE Workbench). The Purdue Enterprise Reference Architecture (PERA) has been applied in combination with enterprise modelling tools, and extended with the STEP methodology. This has led to the specification of information requirements of the VRIDGE Inc. for developing the VRIDGE Workbench. We have identified three inter-related lifecycles in the design of a virtual enterprise. Several modelling tools have been evaluated and utilised. Subsequently, a reference architecture consisting of the Coordinator, the Collaborator, and the Communicator has been proposed for implementing the VRIDGE Workbench, with an aim to improve the effectiveness and efficiency of companies working in the global business environment of the 21st century.

VRIDGE Demonstrator of Globeman 21 project

In the last decade, manufacturing has become global. In order to participate in this kind of global business, manufacturing companies need to develop their ability to respond quickly to customer's requirements, cooperate closely with their global partners, and participate actively and to be commercially competitive in worldwide manufacturing projects.

The *Enterprise Integration for Global Manufacturing Towards 21st Century* (Globeman 21) Project has been formed within the framework of the international research program on Intelligent Manufacturing Systems (IMS) as an international consortium to develop and demonstrate the enterprise integration tools and methods to enable a manufacturing enterprise to form a mission oriented project enterprise, ie., a virtual enterprise, for global manufacturing business.

The *Virtual and Real Information Technologies Driven Global Engineering / Enterprise* (VRIDGE) demonstrator is one of Globeman 21 projects. It aims to develop and demonstrate the lifecycle design methodologies for the virtual manufacturing enterprises and their product. The VRIDGE project envisaged a global virtual manufacturing enterprise *VRIDGE Inc.* that carries out the design, procurement, construction, and manufacturing of a one-of-a-kind product.

A virtual enterprise is a loosely coupled enterprise which is formed by many partners (whole or parts of real companies) to fulfil a specific mission. The motivation for constructing a virtual enterprise is to enable a group of individual real enterprises to operate more efficiently and effectively as if it is a single global enterprise. Enterprise Integration is an enabling technology for developing a virtual enterprise from isolated enterprises. It consists of the methodologies and technologies for virtual enterprise design and operation, as well as the enabling information and engineering technologies for supporting the design and operation of the virtual enterprise.

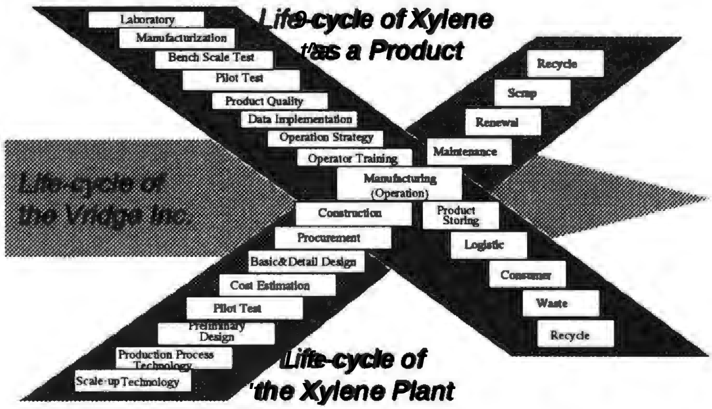

Figure 1 Lifecycles related to the VRIDGE Inc.

Like any real enterprise, a virtual enterprise can be formally defined in terms of an enterprise model, to describe how it is conceptually composed of and how it works. However, a virtual enterprise is to be formed quickly to provide a prompt response to customer's requests, a methodology specially for virtual enterprise modelling will therefore be essential to support the rapid business development. Furthermore, since a virtual enterprise is integrated using advanced information technology, one of the major tasks for virtual enterprise modelling will be the identification of requirements for product information access and control, as well as its enabling information infrastructure.

The identification of lifecycles also helped us to focus on the business process of the VRIDGE Inc. In order to have a better understanding of how the VRIDGE Inc would operate, we canvassed a process scenario called *"Success Story"* to describe the business process from Bidding to Operation and Maintenance. The story also defined the roles of business entities identified in the previous phase.

The VRIDGE Workbench of Figure 2 will also be designed and implemented to provide a demonstration platform. The experience gained is expected to contribute to the development of a virtual enterprise design methodology, and facilitate the design and operation of future global engineering / manufacturing business processes. The proposed VRIDGE Workbench will be implemented in two phases. A proof-of-concept workbench is currently being implemented, and expected to be finished by the end of 1998. This proof-of-concept implementation will then be used for experiment and gathering feedback from users. After necessary refinement, the full scale workbench will then be implemented and used to demonstrate the design, construction, and the operation of the VRIDGE Inc.

for experiment and gathering feedback from users. After necessary refinement, the full scale workbench will then be implemented and used to demonstrate the design, construction, and the operation of the VRIDGE Inc.

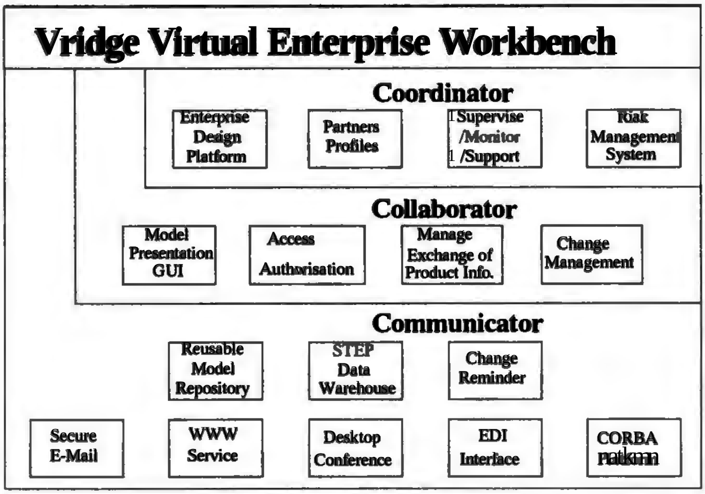

Figure 2 The Architecture of VRIDGE Workbench

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Biography

Masashi Shinonome is a project leader of VRIDGE Demonstrator of Globeman 21 project, an international project under IMS Program. He has been working with Toyo Engineering Corporation 20 years as a chemical plant process designer, plant operating supervisor, designer of CAD/CG systems and projects manager of one-of-a-kind projects of both Engineering /Procurement Construction of a chemical plant and systems development. He is a member of Technical Committee of Globeman 21 and a Communication Coordinator.

Electronic Commerce and Electronic Government

From the Citizens Office towards Multifunctional Service Shops

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1. Introduction

Redesigning the public sector will come high on the agenda for the next decades. But few proponents of administrative modernisation already realise to which extent the availability of IT, of global multimedia telecommunication and of the ensuing ubiquity of information will question traditional tenets of administrative work. IT will provide opportunities to transform the processes through which public administrations accomplish their tasks.

Yet these opportunities are seldom perceived in their totality. Three main lines of IT use in public administration and of administrative reform may be distinguished, but all three concur in blurring the perception of the "enabling" potential of IT, to a point where we have to ask whether the reform potential will sooner or later be used to devise bold solutions for public governance in an "information polity". These three main lines are:

- Traditional infrastructure-oriented IT policies in public administration;

- New Public Management, whose proponents use to pay lip service to "Modem Information (and Communication) Technology" (IT, ICT);

- The development of National (and also transnational) Information Infrastructures (NII) which provides a new impulse with the growing penetration of Internet-based applications in fields like banking or electronic commerce. Increasingly, this new wave of interest in IT is also attaining public administration.

All three streams of current practice fall short of answering the crucial question in a serious and consistent way: "How do we do our business now that information technology exists?" (Muid, 1994). Under the impact of NIIs, there is a multitude of showcase projects at the citizen/ administration interface, more with a view towards proving the usefulness of the infrastructure than actually addressing the problems of the domain of public administration. But the daunting task of redesigning public action, public information gathering and public service delivery, in the light of new forms of human-machine (tele-)cooperation made possible now, is hardly perceived, let alone tackled. The question of how the business of public administration can be done in the future is mostly answered from a parochial point of view of existing organisations who strive for survival under changing conditions.

This contribution tries to show that telecooperation can open up new ways of organising the production and delivery of public services. In doing so, it focuses on the citizen/ service provider interface in a way which also takes possible reorganisations of the process of service delivery into account.

Looking at the potential of the technology, we perceive now quite clearly the immense opportunities for thoroughly changing the ways in which the public sector accomplishes its tasks. Innovative information systems are within sight which will be based on a networked information infrastructure with multimedia capabilities, making use of advanced concepts in the field of CSCW (Shapiro and Traunmüller, 1993). They hold great promises, e.g. for better information for citizens and referral services, new forms of delivery of public and commercial services through one-stop shops, including citizen feedback as part of quality-oriented policies. Traditional boundaries of organisations may become irrelevant, e.g. through providing access to services not only at the place where the service is produced, but at any point of a network.

2.Telecooperation

During the last two decades, "networking" and later the Internet were used as formulae which one only had to mention in order to eschew any further questions about what happened in the different fields where some types of IT-support were introduced. Replacing this formula with another one, namely *telecooperation*, may at first glance only amount to replacing one guiding vision of technology use with another. Yet it captures the essence of the new way of performing informational work (at operative level, at management level, as well as at the policymaking level) in a time where information technology both has come of age and is better understood in its role for the ways in which human beings communicate, process or retain information.

Telecooperation is understood here as cooperation in performing informational work processes. This cooperation is ubiquitous, i.e. it happens regardless of where human actors and technical artefacts are located.

What are the characteristics of information systems supporting telecooperation? The central features are communication and cooperation, understood in a wide sense englobing (formal and informal) coordination. In any case, there has to be an element of support of human cooperation in informational work processes. The two cornerstones of this support are strictly synchronising workflow systems, on one side, and groupware systems which afford less formalised types of coordination of human informational work, on the other.

It is important to observe that there is no truly simultaneous cooperation in the realm of information. With regard to information, cooperative work always implies that one person performs an operation and then communicates the results to other persons. Coordination of the work items therefore presupposes a common language which supports that communication. This makes a crucial difference with cooperation in producing industrial goods. In some instances of the material world (e.g. rolling a heavy log), cooperation is simultaneous: only if several persons join their forces will the work be done. In other instances (the assembly line), coordination of the individual work contributions does not require that the individual workers communicate with each other in a common language or understand the production plan which they have to follow.

3.A multifunctional service centre as a customer-friendly alternative to "Internet self-service"

One variety of telecooperation is the "telepresence" of backoffice staff in a (distant) ffontoffice, e.g. a one-stop citizen centre or service shop, in such a way that a citizen may interact with them, either directly or with the help of another locally present person. In a pilot project carried out in Norway (1993-1996), 7 multifunctional service bureaus were set up in rural areas. All of them gave access not only to the services and information provided by the local governments in charge of running these service outlets, but also to the services of other public bodies. In three cases, videoconferencing systems with an application sharing facility are used to establish direct contact between citizens coming to the service bureau, on one side, and the labor office or a social security agency, on the other. Officials of these agencies provide guidance and perform all necessary operations online. Documents can be printed out in the service bureaus. Despite technical problems as well as organisational problems in the labor offices, this videoconferencing system found widespread acceptance among the citizens concerned.

Another case in point are multifunctional neighbourhood service centres [Lenk 1995]. The "BürgerBüro" (Citizens Office) project in the Land of Sachsen-Anhalt (northeastern Germany) has set up "service points" in rural areas in the form of one-stop shops where public and commercial services of different kinds can be obtained [Lenk 1995, 1997]. These services are generally information-intensive, including e.g. mail, banking, local government functions, tourism, and access to general information services. The Citizens Offices operate as multi-functional points of service transfer. They are set up and maintained by local government, which also negotiates the contacts with public, non-profit or commercial service providers.

A consolidated outlet for multi-service provision in rural areas constitutes a fairly complex innovation. In multifunctional service shops, a wide range of services is provided by agents who cannot have a qualification high enough to span such different fields as banking, tourism, car registration and consumer information. Their role is more that of a sales agent in charge of service delivery, than that of a person *producing* the service. Quite like in the distribution of goods, *retail service shops* will thus emerge. This means that services consisting mainly in the processing and communication of information can be delivered anywhere, without there being a need for the customer to appear on the premises of the service producer.

Under such an arrangement of advanced telecooperation, the main qualification requirements of locally available staff have not so much to do with functional specialisation, but rather with communicative skills and with a general overview over many services instead of specialized knowledge in various service fields. One of their most important functions will no doubt become a role of mediation between the citizen (consumer) and "background" service supplier.

To meet the increased demands put on staff in the multifunctional service shops, a multimedia link is established between these service workers and specialists of the various services which they provide. Advanced multimedia-oriented communication technology comprising desktop video conferencing as well as application sharing (e.g. two persons working on the same document over a distance) will permit to operate an on-demand multimedia link between the service outlet staffed with 1 or 2 persons, and baek-office personnel which is competent to answer any difficult question arising in connection with production and delivery of a determined service. The multimedia connection will also support personal contacts between citizens on the premises of the service shop and back office staff at some remote location. This contact can be mediated by local staff in what might be called a "trialogue".

The reference model of a network of multifunctional service shops, as developed at the University of Oldenburg [Klee-Kruse and Lenk, 1995], leaves wide scope for adaptations on the local level, especially with regard to the emphasis given to the different service functions. It is also conceivable to combine it with telework arrangements. We expect that different types of new multifunctional service shops will soon be developed and become operational. Many service providers are understanding that they must look for new ways of offering their products, and that automated self-service often does not meet the cognitive skills of customers. And many public administrations are beginning to understand that their own prospects are better served by investing into the future, instead of pursuing narrowly conceived cutback policies.

4. A new structure of service delivery

If service production is split between a remote backoffice and a local frontoffice, new ways of division of labour can be introduced which so far were not possible because of the fact that many services have to consumed at the very moment of their production. The skills of remote specialists can be brought to bear on service processes which provide a citizen-friendly interface in a local setting. Also, access to internet facilities can be mediated by multifunctional service shops, providing an "on-ramp" for the technically and functionally less literate to the "data highway".

To make such a service delivery scheme operational, a multimedia communication link has to be established between these service workers and the specialists of the various services which they provide. Advanced multimedia-oriented communication technology can be used to operate such a permanent multimedia link between the service outlet staffed with 1 or 2 persons, and backoffice personnel competent to answer any difficult question arising in connection with production and delivery of a determined service. The multimedia link also supports personal contacts between citizens on the premises together with staff of the service point, on one side, and the backoffice personnel of various service providers, on the other, in what might be called a "trialogue".

The new structure of service retail shops provides an opportunity to bundle services in function of what clients may need, regardless of who produces these services. At the same time, a human interface between the client and the service provider is preserved.

This way of providing services adds to several other ways of gaining access to services. Public services can become accessible from a variety of client-centered service points, as well as from the home. The range of choice spans from

- *municipal neighbourhood one-stop offices* functioning like miniature town halls, over

- *purpose-oriented offices*, e.g. a central office mediating the electronic inspection of ...ative records kept by any agency, to

- *multifunctional service centers* working like a travel agency, offering a wide range of public services from different providers, as well as commercial services like insurance or banking.

Still another model might be referred to as the *virtual office*, where several formally independent agencies are made to appear as a single one. The citizen who enters the office of one agency would get immediate aecess to the services of all of them.

The need for staffed service points like client-centered offices is often contested by pointing at the prospects of self-service "kiosks" and of tele-administration at home, made possible over the Internet. Obviously, a coalition of budget cutback requirements and of interests of hardware and software vendors promotes such a view. Yet it seems unfounded to a large extent. It can be safely assumed that much of the present range of interaction with public administration continues to require face-to-face encounters and some sort of interpretatory effort to make administrative language understood by ordinary citizens. Therefore, remote access to administrative services and interaction from the home, a terminal cabin, a neighbourhood centre or from a public library should never be the only option left to citizens who might wish to expose their case personally.

5 Towards better practice

Despite some encouraging pilot projects, the practice of administrative reform has not yet come to profit from the unprecedented situation of innovation and reform opportunities which ICT offers. The enabling role of information technology can help to bring about the requisite structures of the public sector of tomorrow. But the prevailing patterns of using it are far from exhausting the potential.

The opinion that IT is not significantly contributing to administrative modernisation is still widely shared among reformers in the New Public Management community. How can we make clear that this amounts to a fundamental misperception? This misperception begs the question whether the innovative potential of information systems in public administration will remain dormant forever.

Eventually, the consequences of new structures of service delivery will affect the very organisation of the public sector. A virtual administration will gradually emerge. The fragmentated and multi-layered character of present public administration will be concealed behind access structures which no longer follow exigencies of service production but rather concepts of whole-person oriented service delivery.

It is urgent now to develop reference models inspired by visions of a modern public administration and of the potential of IT. The "Citizens Offices" as rural multifunctional service centres had first to be developed conceptually in order to create an implementable blueprint permitting to take the hurdles which the implementation processes sets up. Similar efforts are now required on a much broader scale, putting into question basic notions like administrative jurisdiction and the territoriality of public administration (Frissen 1997). This implies new bold and comprehensive approaches to administrative modernisation, beyond managerialism and a few theories borrowed from economics.

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GLOBALIZATION, SECURITY AND DEMOCRATIC ENGINEERING ELEMENTS FOR TELECOOPERATION

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Abstract

The paper made, by means of the presentation of the object of an institution: the Foundation for the Study of the Security of the Telecommunication, with reason of the constitution of a service of certification of the electronic communications, the basic proposals for a theory and practice of a democratic engineering of software.

1. Introduction

Telematics, technique that allows the transmission of data at distance using electronic means, requires of who use it the setting in practice of what comes to denominate telecooperation. This means that is necessary to assume the intersubjectiv character of the activity carried out by the users of the telematic products. It is this way because the use of these products always requires the establishment of relationships among people of several places. This has the result that the practice of the telecooperation demands of the designers of telematic products to satisfy the demands of the technique and the behavior rules characteristic of a plural society. Rules that are identified merely by the beliefs and cultures characteristic of the individuals that begin relationships or communications by means of telecooperation.

His forces to that the design of products counts with the phenomenon of the globalization, 'iwning that globalization is not the same thing that unification but many people's coexistence od, therefore, cultures. It is necessary, for it, even a communicative or democratic engineering that biseaan^ppropriate design of applications to a plural world.

for this reason the design must respect the technical principles with those that the telematic ipplications are made and especially, as prerequisite, it must satisfy the measures of security that llow that the communication takes place, preserving the principles of authenticity, integrity and (I^dentiality of the communications that are basic for the setting in practice of the applications. He design must also assist, inexcusably, to the measures of security that are in process of juridical regulation in the developed countries.

hlhis sense the paper present the fundamental features of the project AEQUITAS that, through the ^gplication FESTE, puts into practice the characteristic principles of a democratic engineering sftware in relation with security measures for the electronic transmissions..

ForitEe following things are here exposed:

a the first section it is considered that products and telematic networks are usually made following ules of technocratic character, without assisting to the social demands or the cultural plurality, in ipite of the fact that the installation of the nets has juridical and political consequences as it is observed studying a phenomenon of wide repercussion as the security in Internet.

ta the second section it is shown that the practice of the cultural plurality is fundamental for a global world, existing to these effects theories that coincide, in areas so different as the law and the ejjoeering, in proposing a professional practice guided by the use of techniques and the social acceptance or the informed consent that is in laws, measures of security and behavior codes..

He third section picks up that FESTE is an institution that, as practical exercise of democratic theories (juridical and computer), gives concrete rules for the design of telematic products assisting to the laws and therefore in coherence with the principles exposed in the previous sections. At this

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time FESTE carries out this design by means of the constitution of a certification service of the electronic communications.

2. Security in Internet

When we speak of telecooperation we refer to communication by means of the electronics, what takes us in an immediate way, for the present time, to keep in mind the weaknesses of the transmissions of data, the technical solutions that are given to the same ones and the juridical problems that such solutions behave..

2.1 Weaknesses

The weaknesses consist in that the mechanism of operation of the networks of communications, and especially of the net of nets: Internet, allows the interception of the messages for their users. The net works by means of the shipment of packages of information between originators and receivers from one to another part of the world using to the connected computers to the same, what behaves that it is very easy to observe the content of messages, for example in those that consist numbers and keys of credit cards, or any other type of communications maintained by the users. This generates several disadvantages of the means, the main is that this practice goes against the security and trust of the electronic trade, source of wealth and work. That which worries industries and governments and, at the same time, limits the expansion of Internet. It is this way because the trade freedom or the same fact of the telecooperation cannot be satisfied if channels of transmission of the information so vulnerable exist as the existent ones, or if technical solutions contrary to fundamental principles of the established juridical regulation are adopted as that of the secret of the communications. This is specially dangerous for the practice of the telecooperation, because it decreases his possibilities if the trade doesn't work or if the products created through the nets of communications are not trusted

The solution goes by the combination of technical and juridical procedures as next it is pointed out

2.2 Technical solutions

The establishment of nets has begun constituted by services and offices of trust that facilitate guarantees in front of the weaknesses of Internet, when assuring, especially, the identification of those that send and receive messages and the confidentiality and integrity of the same ones. These services are required by the widespread acceptance of the use of cryptography or the techniques of ciphered as instrument of security of the electronic communications.

The technological development has allowed to begin the expansion to world scale of these measures as it demonstrates an fact as the programs Netscape, version 4.0 Communicator, built by the American company Netscape Communications, and Explorer, of Microsoft, the two access interfaces to more extended Internet in the world, are in the market.

* Among the most significant novelties in these programs it is the offering of programming resources "cated to guarantee the security and trust in the electronic communications by means of the tography. In short they allow to their users, be the one that is the place of the world in which the ciphered of the messages, the electronic signature, the acknowledgement of receipt and the exercise of all the precise mechanisms so that the cryptography is put into practice.

Another important fact of the question resides in the fact that the mentioned programs put into practice the characteristic functions of the Services of Certification (the user's identification and validation of the identification by means of certification of its identity or of their attributes), by means of companies located in United States, with regard to people, users of Internet that send documents or messages from different parts of the world to other users of Internet. To carry out their function these companies have only the genuineness that gives them to have been included by the companies Netscape or Microsoft in the list of Services of Certification that is picked up in their product. This is that Netscape or Microsoft work practically as entities of acreditation of certification services.

Here the problem comes. The question is: can it be a network of global trust? Would the certification of a transaction using Communicator or Explorer carried out by a Service of Certification, company, resided in United States have probatory value before a judge?

That the answer to these questions has of being of negative character it demonstrates it, for example that these facts require in Germany that the Services of Certification for the companies Netscape or Explorer must fulfill the requirements settled down by the German law expressly. Especially the one that says that the action of the Services of Certification of countries different to those of the

European Union will require the existence of an agreement signed among the respective governments. Also it is in this sense a Proposal of Directive of the European Union (COM(1998)297/2) of May 13 on a common framework for electronic signatures.

Why the legal regulation?.

2.3 The threatened Rights

The biggest problem proceeds that indeed the cryptography solves the problems of the identification and even confidentiality or privacy, other many problems subsist. From a juridical point of view the most fundamental is the problem of the power. In short the problem of the possession of the keys of ciphered and deciphered. In two cases: the safeguard of the keys and the identification of people. So much in one as in other the possessor of the keys can dominate the user of the same ones, with more effectiveness even that with the use of the weapons. It must keep in mind that the application of the techniques of ciphered requires indispensably the performance of thirds, well be the denominated certification services, well be the denominated registration services that have as function the storage and registration of the public key that a person has declared are his, and the storage and registration of the personal data, even the private key, of the proprietor of the public and private keys. This is one of the reasons for those that the cryptographic resources are compared those of armament in the regulations to the export of products of double use.

The problem of the power of the key derives in other: the restriction to the freedom of speech. It is this way because the technical solutions, mainly those that prevent to observe the content, facilitate the freedom of speech but also hinder and in occasions impede actions directed to the prevention of the crime: the interception to the telecommunications of legal character. That which requires the establishment of measures that allow the interception of messages for the services of security and with it the generation of possible excesses that can affect the priciple of freedom of speech, besides, of course, to that of personal privacy.

A problem not smaller, also more concrete than the previous ones, it is that the installation of measures of security, consistent in the use of technical of ciphered, requires the establishment of adjusted organizations at the present time to the nets of security and trust of the economic, social relationships and existent communications, from begiinings of the XIX, at the same time that the liberal State was implanted. It is in that moment when public registrations were constituted. These registers had for function to facilitate and to protect the exercise of the rights of people at the same time that to guarantee the mercantile traffic and the right to vote. The fundamental problem in this environment resides today in that the telecommunications, whose resources by means of Internet are used in first place in a country of Anglo-Saxon law as United States, with different organization to those of most of the European countries, they are introducing as basic agents or certification services of the net to companies or institutions of new design, with that which the new techniques change in the practice a fundamental juridical system of the State of Law: the system of public faith whose pillars are constituted by different agents: notaries, trade corridors, and public registrations of judicial or administrative character.

Of there the necessity arises of modernizing the legislation from each State to effects of establishing the conditions of use of these technical ones and also the demand to the telematic engineer that carries out any application, that it is attentive to this legislation.

3. A democratic professional practice

The unification of practices that brings the use of the same techniques and computer products in the entire world in real time makes frequently to fall in the forgetfulness of something that is also real. This fact is that the uniformity of the world is apparent. When one separates the view of the monitor or deepens in the meaning of what go through the same one, what verifies it is that a plural world exists. A plural world whose plurality is manifested in the differences that are observed in the daily life. Differences that capture in the distinction of professions, cultures and, also, why not, in the separation among rich and poor.

Indeed, one of the biggest problems of the developed societies is the fact of the progressive distance between vast sectors of the people. This brings difficulties to the social relations. There are violent actions, in many occasions class, race or cultural conflicts. We think in Yugoslavia, also in race conflicts in the United States of America. However they account also in towns of our cities.

The distance exists also when the Governments approve political decisions pro the social participation. The violence continues because it is difficult the accommodation of the people that had nothing before, with the people that had something or many. And vice versa. If there is an accommodation of all incomes, or it is established the political equality in relation with the right of election, another differences exist, and the point of reference is the church, the language or the culture of each person. Culture, religion, use, custom, languages are the excuse against the equality. The two parts prefer to reject or to restrain to the others.

The non recognition of this fact can have important practical repercussions. This ocurrs when the telematic techniques are introduced in the practice daily, because these techniques can generate conflicts if they are not coherent with the complexity. We must keep in mind that the repercussi(^| will be more big when these techniques are of habitual use for the entirety of the citizens. Today this is not still a fact, the telecooperation is only between the persons of the developed societies that have a high degree of formation.

One of these consequences is that if these techniques don't assume the plurality or the social conflict, and everything is standardized by practices generated by uniform techniques, we will have fallen in the great brother's nets that knows all, watches over all and it controls, especially because everything moves in oneself, standardize, controllable, world. That we are not so far from this fact, it demonstrates it that practices, reflected in the previous section, carried out for fabricants of software of communications exist that, in something as crucial in these moments as it is their security, have established systems preserved by cryptographic networks that allow to protect and deprive the privacy of the telecommunications, by virtue of the application of the rules of the market. We refer in short to that the two companies leaders, Microsoft and Netscapoj Communications, are building nets of security, having the practices acquired by this companies and those of who carry out agreements with them, constituting what are denominated services of certification of public key and registration entities, to the margin of the certification and registration systems characteristic of the democratic societies from beginnings of the XIX century..

How is possible the integration?.

The best form to end with the social exclusion, is the promotion of the inclusion trough the participation of all people in the development of the telematics products, when it can be possible. It is not possible with the present dominant technical and scientific discourse, that stops the participation in all activities to the people from different culture to the culture of the majority.

A possibility to overcome these borders to the inclusion is the elaboration of a communicative theory of telematics, on the design of the products and the practices of the institutions that the engineers generates them. These theories propose as direct object to the activities of the engineer the permanent participation, trough the agreement of all people that participates in each engineering activity.

These are the thesis of this section, in that the first proposal is on the limits of the usual theories and the second is on a communicative theory. The paper presents these theories from the exam of the theories of law. These theories can be a good example because telecooperation is organization of the human relations and the law is the most relevant organization of the human relations in a democratic society. Starting from the juridical example, the proposals become computer proposals by the specification as summary of the characteristics of a democratic engineering (section 3)

3.1 The barriers of the usual theories

The scholars that made theories of Law work on a limited reflection. This is a reflection on the nomi, of limited purport as Atienza [3] acknowledges. It is because their proposals are reduced to the analytic construction of the legal texts. They work also only with some legal texts: the Constitution or the laws made in the Parliament. For them it is not possible to study the content of other juridical norms, as the reglaments of governmental character or the judicial sentences. Other norms have not relevance.

However these other norms are used in the everyday practice. These are norms as the technical norms elaborated by experts' committees, the codes of practice, the estatutes of associations, the custom, the contracts... These norms are not build by public agencies, but in the reality they are considered as legal norms, with the label of principles in many occassions, as Alexy [1] says.

The use of these norms is required by many reasons. In occasions because they are used by the people that have them created out of the juridical methods. Hart [8] argues that in occasions the „open" legal norms made implicit or explicit remissions to those norms, and they must be taken in consideration in the juridical processes.

For this reason the classical theory of law of authors as Kelsen [10], that understands the norms as imperative of the state, has not practical utility. This theory has not interest for the jurists, the addressees of the theory.

3.2 The communicative theory of the norm

It is necessary a theory of the different existent norms. A theory on the everyday used norms. The main affirmation of the theory must be the next, made from the theory of social systems of Luhmann [11] and the theory of communicative action of Habermas related with the Law [6]. The definition says that the norms are joints of words or sentences, that are grouped with the end to obtain the justice. The fulfillment of the justice is obtained by the participation of all person involved in concrete cases or juridical activities. The activities can be the access to juridical texts, their interpretation, the construction of legal doctrines and the application of the Law. These activities are made normally in concrete institutions.

This theory is congruent with the fact that in the juridical activities, the jurists always use norms made by the State, their different powers, or by organisations or public or private institutions. Maccormick and Weinberger [12] speak on institutions. With the theory the jurists or the civil servants of the Administrations can know not only the legal texts but also the economic content of the reality, by the knowledge of the rules of the Economy or the Statistics. They can know also the rules of conduct made by professionals, experts, churches, firms, associations of firms, trade unions, people of different cultures. The theory is congruent with the characteristics of the juridical action in the democratic society. See in this sense to Rawls [14] and Habermas [7].

The theory is, first, a communicative theory of the juridical norms elaborated from the communicative concept of Law, as Galindo [5] says. The theory has as object to made of the norma an element of communication, consent or agreement for juridical activities made by jurists of different institutions in a plural and democratic world. This object is different to that of the classical theory of the norm, that has as object the formal construction of the mandate of the State.

The most important consequence of these theories is the method of action that proposes for the jurists. The method consists to have consideration for each activity to the facts of the problem, norms related and convictions of all participants[1].

In the same sense it is necessary a communicative telematic theory that is not only centered in the study of the conectivity mechanisms but rather must assist also to the context of the connection or the communications. It must be considered to the participant cultures so much all that to the institutions that allow the connections.

Said this in another way, we must think that the computer knowledge as the knowledge in general intersubjetiv [2] [15] that the theory and computer science practices cannot be far from the values [9], and that they require the informed consent of clients and users of computer product [13], or what is the same thing, from another perspective, that is necessary the setting in action of a democratic engineering (next section)

3.3 Democratic engineering

All until here expressed means that the expressions to analyze and to program are insufficient to denote the characteristics of the activities of the telematic engineers that must generate products dedicated to the telecooperation. It seems more based the opinion that estimates that the most characteristic activities from these engineers are identified when manifesting that are the following [16]:

1) Agreement on the user's necessities;
2) Delimitation of the functional specifications of the application;
3) Construction of the program;
4) Validation of the program, and
5) Elaboration of forecasts for the exploitation of the system.

In this section we make a brief comment on these actions.

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[1] This method is complex for jurists. However there are procedures to overcome the difficulty. For example the knowledge and use of the system' theory. See an example of the virtuosities of the method in the area of Law in

The first of the engineer's fundamental activities consists on the agreement on the user's necessities. It is consequent with the requirement of the informed consent that is claimed socially anyone that wants to build a computer system, and much more if this is a telecooperative system that must be acted by a diverse group of people that lives in different places of the world.

The general justification of this activity resides in the need, felt progressively by a bigger number of people, that the activities of the engineers should be guided by the respect to the particularities of the users of the applications. It responds, among other things, to the fact that the designers make options from the first moment in that they act professionally, being bound through contracts or commitments with one or other responsible (private, public...) of the programs. This is to accept that ends or values import also.

It is also necessary informed consent for the bound activities to the programming, in short to specify the functional specifications of the application, and to build and to validate the program. This obeys to the following thing.

An aspect is the relative to the election that the engitmeers carry out of an or another programming technique to develop one application. It is important because it is not indifferent the use of one or another type of language or method of programming, since this decision influences in the construction of prototypes, in the development of applications and in their implantation, in their consequences for the users or even for the environment... In this election influence values. By virtue of the prevalence of one or another the application acquires some or another characteristics.

Another facet is the type of approach toward the social reality that the technical people makes. This people builds the applications or programms with reference to personal convictions or the context

It is also a need a computer activity of agreement referred to elaborate forecasts for the exploitation of the system or applications. It is because the expansion of these technologies in fast all the environments of the life, it is producing a change of the social habits. Until the point that although the concrete actions of who use them are his responsibility and as soon as such they are work of their convictions, in good measured they are also affected by the general peculiarities that confer them the characteristics of the applications, and for it, also, for the ends or values in those that

DeBessonet [4]

believe the people that has participated in their design. Mainly for the ends or values in those that believe those that prepare the uses of the technique: industries and governments.

For it we can already sit down as hypothesis that the activities of the engineers must be guided by the justice, or what is the same thing must be justified or motivated by technical approaches and, especially, for approaches or values recognized by the laws or for the behavior codes. This is a democratic engineering.

4. FESTE

Only a democratic engineering as the one expressed can be developed in the environments of cooperative work whose construction begins in these moments. This is the case of what promotes the Foundation for the Study of the Security of Telecommunication (FESTE) with the purpose of satisfying the exposed telematic necessities at the beginning of this paper in that referred to the security of the communications.

Here we express the one made of FESTE after exposing the general notes of the investigation AEQUITAS that has preceded it.

4.1 AEQUITAS

AEQUITAS is an investigation project that finally has to reflect on how the evidence in criminal litigations of ciphered electronic messages and signed electronically is possible.

The project began in 1997 as an investigation project, selected through the corresponding competition public, promoted by the European Union, General Directorate XIII-7, group INFOSEC, Security of the Systems of Information. From the beginning of 1997 until the present time the project works together with other seven European projects with the objective of building between all the basic infrastructure so the constitution of an European network of services of trust of the electronic communications. This year (1998) other seven projects have been incorporate to the same work

The project AEQUITAS was put in practice from their beginning thanks to the participation of a group of thirty Spanish and French jurists of different professions and work place. The investigation group was constituted by teams of Philosophy of Law and the School of Engineers of the University of Zaragoza together with the Spanish company Intercomputer S.A., specialized in the development of telematic systems.

The beginning of the project was limited to gather information to reach the final objective of the same one that is constituted by the elaboration of a Report on the evidence in criminal litigation of ciphered messages.The information is integrated by the study and summary of the legislation and existent technical measures to achieve the trust of the electronic communications, and for the same thing the possibility that they are considered evidence in litigation. The other great part of the information to which assists the project is constituted by the experience acquired by the group of jurists users in the use of these techniques in their daily professional practice, in the relative to the transmission of messages and the access to documentation systems.

Through the reports emitted by the project until this moment, the project has left elaborating different proposals of European and State normatives referred to the establishment of measures of trust of the electronic communications, those which, in more or smaller degree, have been reflected in normative approved or in approval phase for the European Union from the second half of 1997. In short the Communication (97) 503 of October 8 on „The development of the security and the trust in the electronic communication. Toward an European framework for the digital signature and the ciphered" and the Proposal of European Directive on „A common framework for electronic signatures", Communication (98) 297/2 of May 13..

In these moments the project AEQUITAS has finished the final Report whose fundamental subjects are the following:

1) Digital signature,
2) Entities or certification authorities,
3) Registration entities,
4) Their object, function and ends or values,
5) Certificates: classes,
6) Recovery or deposit of the private key, and

f) Contracts, regulations and indispensable practice codes for their operation.

The review of all these elements will allow to constitute the nucleus from an juridical institution to become that well can denominate digital signature whose setting in action, by means of the work carried out by the denominated certification services, will grant probatory value in litigation to the electronic documents generated with its aid.

At the present time AEQUITAS has become an investigation program in whose setting in practice participates Notaries and Corridors of Trade, Procurators of the Tribunals, Lawyers, Judges, Ministry of Justice, Institutions of state, regional and local character and the own European Union.

In the frame of the investigation program AEQUITAS institutions are building. Especially certification services and systems of trust. Norms of National and European environment are also generated. An excellent product of AEQUITAS is the constitution of the Foundation for the Study of the Security of the Telecommunication (FESTE). The Foundation has for object the realization and promotion of studies and investigations on the matter. It also operates as system of trust.

FESTE

The inadequacy of the solution given by techniques, norms and institutions to the necessities exposed in the first section of this document motivated to the General Council of the Schools of Corridors of Trade of Spain, the General Council of the Notaries of Spain, the University of Zaragoza -Areas of Philosophy of Law and Cryptography- and the company Intercomputer S.A. -company specialized in the development of telematic applications in bank environment-, to constitute the Foundation for the Study of the Security of the Telecommunication, in formation from November 21 1997.

The Foundation has wanted to solve, insofar as possible, some of the deficiencies detected as regards security and trust of the telematic transactions. FESTE assumes as horizon of own action the satisfaction of two basic objectives. In the first place, the proposal to the Spanish competent authorities of the elaboration of a normative that preserves the security and guarantee of the electronic communications and the promotion and elaboration of studies that allow to create a software of cryptography of national character. In second place, the proposal that the traditional notaries can be constituted, as soon as certification and registration services of the electronic transactions, as basic elements of the networks of security and guarantee of the electronic communications that are constituted in Spain. The first example of this performance is the network formed by FESTE, in which the Foundation is constituted as service of certification of public key that invites to the traditional notaries to be constituted as services of registration of the same net.

The two objectives are in execution by the ellaboration of a Spanish proposal of law of Electronic Signature and the begin of the offer of the service of certification of FESTE.

5. Conclusion

Summarizing those made by FESTE, remembering the juridical problems that the use of the Cryptography behaves and that they settled down at the beginning of this paper, it is necessary to say that the Foundation attempts the compatibility of the allotment of power and the use of the cryptographic techniques. FESTE assumes that, like it has been said, the technical remedies are partially effective and they always require to guarantee the juridical demands. For these reasons the technical solutions should be designed assisting to the execution of the legal requirements and not to the inverse one. The fact that the FESTE network is integrated by the notaries guarantees that the allotment of the power on the keys is distributed among many institutions of trust: the notaries. For the case in the one that a citizen decides freely to deposit his private key, or for the eventual case in the one that the Spanish State decides in a future the regulation of cryptography preparing the deposit of the private key, FESTE facilitates that the deposit of the keys is in hands of a network of instances of trust like it is the constituted by the notaries, forced by law to complete this function satisfying the corresponding guarantees. FESTE, finally, leaves in hands of the notaries to ponder the degree of zeal there been in the execution of the interception of the communications on the part of the services of security legitimated for it and the one of lesion to the freedom of speech that can cause certain interceptions.

With that it has been shown a telecooperative example that is working in strategic environment of the society practically because this activity is coherent with the organizational and coexistence principles characteristic of a democratic society. The contribution has been made hoping these experiences can serve somebody that works in similar telematic spaces, be which is him work area.

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Distributed Information and Communication Systems in International Organisations

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Abstract

Increasing demand for electronic publishing services characterises the situation in most international organisations. Electronic mail and the distribution of information in HTML format are commonly accepted standards. Now that these services are in place, the weaknesses of just putting static information on web sites become evident. The larger the documents are, the harder they become to maintain: dangling links, pointers to wrong or outdated information, and inconsistent links to other documents are the first signs of trouble. It is not uncommon that these problems develop into the collapse of a whole site. That is why new solutions have to be developed, and why an integration with existing publishing and database services is so important. The cost for maintaining an isolated web site quickly becomes outrages. Information material offered electronically should therefore be a by product of traditional publishing processes, access to existing databases should be made possible to avoid the manual maintenance of links.

This contribution tries to give an idea of how questions of server maintenance, the introduction of new concepts, and the issue of centralisation vs. decentralisation can be addressed and how an information and communication infrastructure which is adequate for international organisations can be set up around distributed information systems, data warehouses and data mining.

1. The need for a cost efficient solution

For international organizations the distribution of information has become a major cost factor [cf. 1]. That is why ways have to be found, not only to move away from paper based publishing in the long run, but also for making the publishing process in general more efficient.

With electronic mail and web sites being a commonly accepted technology the question is how these services can be used in a less costly and more comprehensive way. Maintaining web sites has become a tedious task, the frequent update of documents indicates that static HTML documents are not the optimal solution. That is why an integration of the web site into the publishing process is a first step which can guarantee that HTML documents will be just one of many possible outputs. A technical concept satisfying this demand could look as follows:

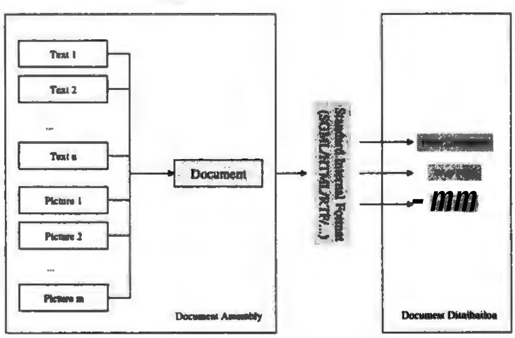

Figure 1: Publishing Process

The essential step will be the conversion of the document into a format which is accepted as universal document standard by the international organization, be it SGML, HTML or a proprietary standard. The key requirement is that this document must still be directly maintainable with the standard text processing and graphics software used in the organization.

2. Centralization vs. decentralization

The technological requirements and the introduction of a common document format are only the first major step, finding an appropriate organizational concept will be more difficult, because a crucial question, to which extent document production, maintenance and distribution should be handled centrally or in a decentralized way, has to be solved. This decision has to reflect the structure of the existing business process or has to deliberately reengineer it. The generally accepted standard procedure is that documents are produced and maintained in a decentralized way, whereas the distribution is taken care of by a central institution, the secretariat or, as is the case in larger organizations, by a dedicated publishing department, which is the only way to perform a quality and content check before documents are published. The technological infrastructure needed for implementing such a process can today be built on Internet technology. [for publishing workflows cf. 2]

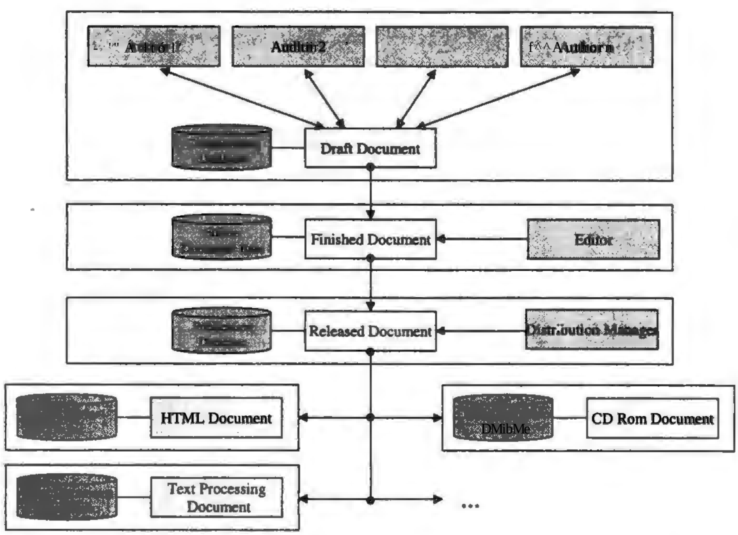

Figure 2: Process and technological infrastructure

This approach could be implemented by establishing an Intranet combining a collaborative environment for authors, editorial software for the editor and a publishing tool for the distribution manger. Once the document is released, different version can be created from it, such as an HTML version for the web site, a text processing format for creating the paper version, or a format in which the text is going to be distributed on CD Roms.

3. Architectural concepts

From an architectural point of view, the implementation has to be database oriented. Considering that the architecture should allow different applications to access different documents, it might be wise to separate the application server from the database server. As the authors might use different tools and systems, the best way is to offer a plug-in for a client browser. That is why adopting the recommendations of Sun Microsystems Network Computing Architecture (NCA) might make life a little bit easier and will also allow for future modules and extensions in the form of additional cartridges, [cf. 3 and 4]

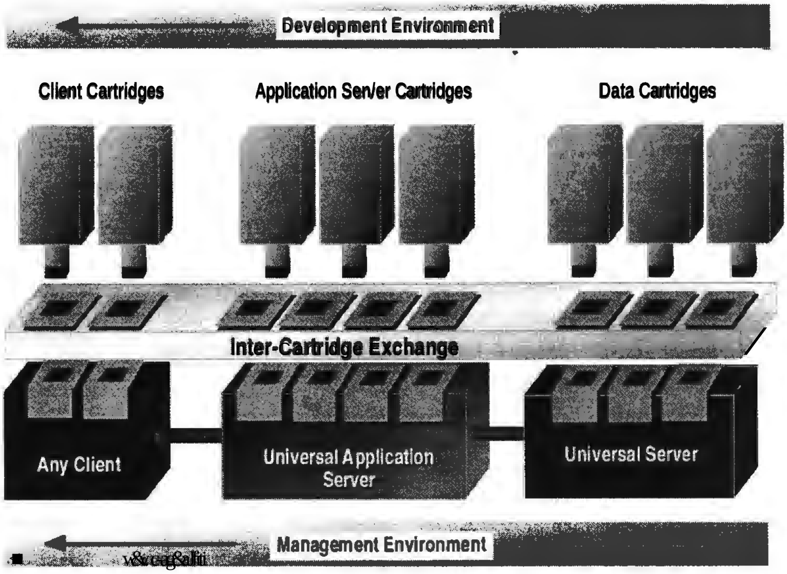

Figure 3: NCA (Source: Oracle White Paper Enabling the Information Age)

4. From administrative support to decision support

Administrative support for producing and distributing information and for communicating more efficiently is just one benefit of introducing web technology into the organization, as can be seen from the following three examples, the use of Internet by the United Nations Center for International Crime Prevention in Vienna, by the IFIP Secretariat in Laxenburg, and the Ethopian EARMIS system.

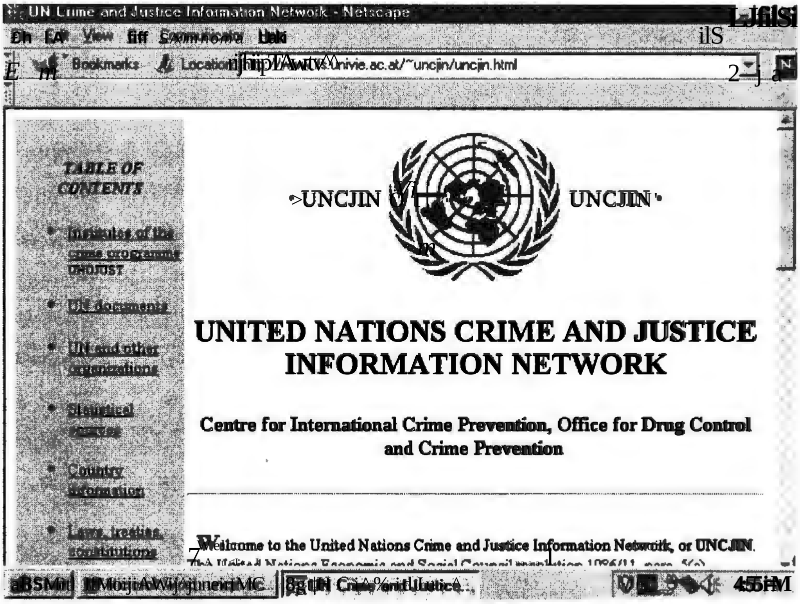

Figure 4: UNCJIN – An information system offered by UN/CICP

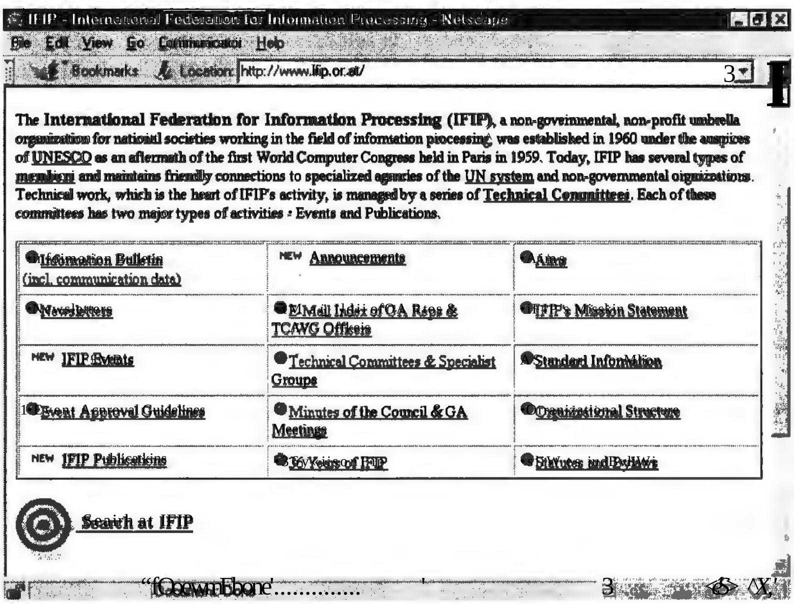

Figure 5: IFIP – services on the Internet

Once a database connection is established and documents are primarily held in databases, search mechanisms can be offered which can then be used for gaining information to prepare decisions. Imagining a highly distributed environment, such as the United Nations Crime Prevention Programme, it would be of great help to ensure that all participating members use the same database tools and architectures. Data stored in the same format, following the same database schema does also mean that it becomes possible to launch simultaneous queries to all databases. Carefully planned, such an approach can be the first step towards building a distributed data warehouse consisting of several locally administrated data marts. The network established through the UNOJUST Program is an excellent example of where the development is bound to go. Starting with giving all participating institutes a home base on the Internet (i.e. a web site), the next logical step to be taken is to provide the institutes with a database system connected to their web site through which they can offer information in a commonly accepted format and structure. Where the web sites and databases are operated from is of minor importance so that for lesser developed partners the site and information service can be hosted by an advanced partner until they are able to take care of the sites themselves, a concept which makes it possible for institutes located in developing countries to participate in the initiative from the beginning. In the long run a virtual private network, an organizational Intranet based on the Internet can be built which allows, besides communication support and the exchange of information between the partners, to create a distributed information system, in an ideal case a real data warehouse. Being able to access this data warehouse for analytical purposes will dramatically change the speed at which analyses can be done.

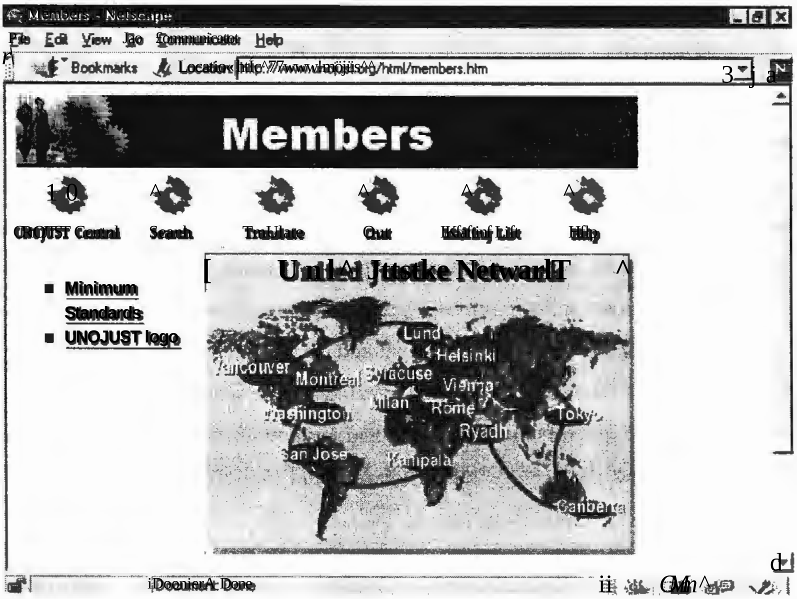

Figure 6: UNOJUST Members

5. A Case Study On Distributed Application In Agricultural Research

Information exchange and knowledge diffusion are a critical and at the same time invaluable component for any research and development organization. In the information age more and more research-oriented establishments are becoming aware of the potential benefits of collaboration, knowledge sharing and wider use of information resources as an asset of strategic significance and high value to their organizational goal. For this reason, they are searching for appropriate and affordable technologies, which allow them to easily communicate with their partners and exchange knowledge and information among themselves. The issue of information exchange and communication become more serious when an organization has a number of geographically dispersed offices and it heavily relies on its relation with other regional and international partners. The case in point is the Ethiopian Agricultural Research System (EARS).

EARS is the largest national sectoral research network for the agricultural research partners in Ethiopia. EARS is characterized by a substantial number of federal and regional agricultural research centers including local agricultural universities and development agencies, and national, regional and international agricultural research centers (IARCs) at an international level. To put it in a descriptive way, EARS mobilizes about eight hundred agricultural researchers in more than 25 agricultural research centers locally. In the international arena, EARS has research partnerships with more than 20 International agricultural research centers and funding agencies.[10]

In Ethiopian context, agriculture is the backbone of the country's economy and remains to be the same for many years to come. Considering this, the contribution of EARS in generating appropriate technologies that enhance the productivity of the agricultural sector and thereby improve the economic development of the nation cannot be overemphasized at any standard. In order to make EARS more effective, the rapid acquisition of information, its communication to the intended users, its transformation into knowledge, and its application to the benefit of the research system should be highly stressed. To achieve these results, information should be managed through effective and capable system which utilize appropriate technology. Specifically, the deployment of distributed information and communication systems that offer tremendous capability in supporting fast and easy information gathering and flexible distribution of the same by any stakeholder in the system is of key importance.

To realise this, the appropriate utilisation of the new and emerging information technologies like Internet and Intranet becomes a better and an affordable alternative.

To demonstrate the underlying concept of such Information System implementation, a prototype system development under the title of "The Ethiopian Agricultural Research Information Management System (EARIMS): A Prototype Implementation of the Internet and Intranet Services" is being carried out at the Johannes Kepler University of Linz and University of Vienna, Austria. This prototype system is an Internet-based information system which comprises the distributed application of mission-critical information services. The main tools of this information system are electronic mail, a mailing list system, file transfer protocol services, on-line conferencing, web-based document publishing and real-time database access services. The following pictorial representation illustrates the framework of the proposed system.

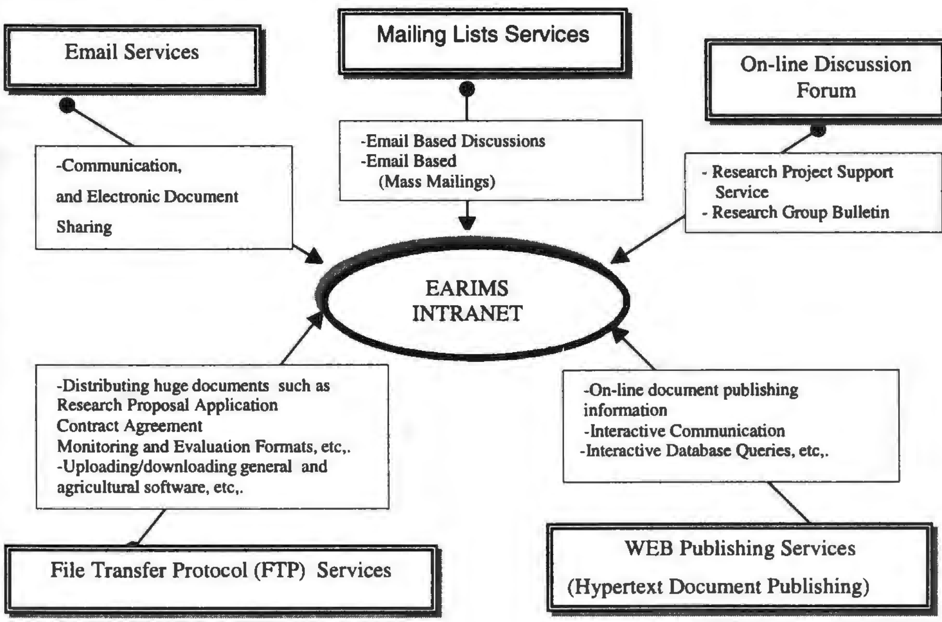

Figure 7: Concept for Knowledge Sharing and Communication Services of EARIMS

Conclusion

Running a web site with static HTML pages and even database access through CGI scripts has become a commonly accepted standard practice for international organizations. With advanced concepts such as the NCA at hand, increased flexibility is added. What has started as platform for distributing information can now serve as basis for integrated publishing systems and for distributed databases which on their turn can be used for the implementation of decision support systems through distributed data warehouses.

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COLLABORATIVE TECHNOLOGIES: ENABLING THE THIRD WAVE OF ELECTRONIC COMMERCE

Bernard Glasson[1] *and Rodney Jarman*[2]

Abstract

Electronic Commerce, which had it origins in EDI, has today come to be understood as Internet-enabled business. The uptake of the Internet in general and the World Wide Web in particular have captured the attention of individuals, business organisations and government's alike. This "second wave" of Electronic Commerce has the potential to significantly improve business efficiency. However, this paper argues that the convergence of Groupware and Internet technologies, in particular the Web, will herald a "third wave" of Electronic Commerce development. This third wave of Electronic Commerce will provided the technology base to allow the virtual organisation to become the dominant organisational form.

1 INTRODUCTION

Electronic Commerce is a relatively new phenomenon. It has its roots in Electronic Data Interchange (EDI) - what we will call here the first wave of Electronic Commerce. Its emergence and growth came with the opening up of the Internet to commercial activity, the uptake of client-server computing architecture, and the almost universal uptake of the

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World Wide Web (WWW) - which we will call the second wave. While the uptake of the Internet for business uses has been quite dramatic, it has been paralleled to an extent by developments in collaborative technologies or 'Groupware'. These two areas are beginning to converge spawning a raft of new applications that will support group or teamwork - particularly distributed teamwork. This we believe will usher in the third wave of Electronic Commerce.

The first wave of Electronic Commerce had limited success. The second wave has captured the attention of individuals, corporations and governments alike. As an example, the organisation for Economic Cooperation and Development made the following statement in its first policy brief on Electronic Commerce.

> "With electronic commerce, the world is on the threshold of a new revolution. Because electronic commerce provides a fundamentally new way of conducting commercial transactions, it will have far-reaching economic and social implications. Current ways of doing business will be profoundly modified: anyone with a computer and Internet access can become a merchant, and reach consumers all over the world. New and far closer relationships will be forged between businesses and consumers; many of the traditional intermediaries will be replaced; new products and markets will be developed." [10]

In another example, Andrew Whinston, a noted Electronic Commerce researcher and author, made the following statement as guest editor of a special issue of IEEE Internet Computing.

> "The world of business is witnessing profound changes under the influences of Internet technologies. It can safely be stated that no aspect of commerce, or indeed day-to-day life, will remain untouched. The pace and scope of these changes draw momentum from an increasingly networked world. In particular, the ever expanding Web and improved seeurity guarantees for business transactions are reshaping the way we think about economic systems and business processes" [17]

The second wave of Electronic Commerce emphasises transaction-processing efficiency - note the OECD's emphasis on "commercial transactions" and Whinston's reference to an "increasingly networked world". Internet-enabled business has the potential to allow any *producer* to enter into a *transaction* with any *consumer* or vice versa and to do so efficiently - and the italicized words are meant to be interpreted very broadly. The second wave of Electronic Commerce, which is still in its infancy, is riding on the back of the World Wide Web. The Web marked the end of an era of frustrating and debilitating incompatibility in communication between computer systems. It brought with it an explosion of accessibility enabling the second wave of Electronic Commerce. But the Web was originally supposed to be for personal information systems and a tool for groups of all sizes, from a team of two to the entire world [1]. And in this regard it is just beginning to show its potential. In so doing, it is forming the third wave of Electronic Commerce.

In the third wave of Electronic Commerce the emphasis will be on effectiveness (in our business processes). And this effectiveness will come about through changes in the way we work as individuals and, more importantly as groups or teams - note the OECD's reference to "new and far closer relationships" being forged and Whinston's reference to "reshaping the way we think about .... business processes". The second wave of Electronic Commerce enables anyone - individual, organisation or government - to transact efficiently with anyone else. The Internet has brought about an increased accessibility in the applications we can use to collaborate. Now we have this accessibility, we can begin to think creatively about the way we work. Thus the third wave of Electronic Commerce will be when the power of the Web is used to change the way we collaborate. Through this collaboration we will achieve effectiveness in our business processes. In this paper we will focus on the impact on group or teamwork.

2 SECOND WAVE

In today's second wave of Electronic Commerce, there are three distinct general classes of application - inter-organisational Electronic Commerce; intra-organisational Electronic Commerce; and consumer-to-business Electronic Commerce [6].

Inter-organisational Electronic Commerce facilitates the management of supply-chain [11] processes. It reduces the cost and time cycles for purchase order processing. It reduces the length of the order-ship-bill cycle. It facilitates document transmission and enables better document management. It enables trading information to be disseminated to trading partners quickly and accurately thereby eliminating hours of work and ensuring accurate information sharing. And it allows payments to be made electronically increasing speed and accuracy. Therefore inter-organisational applications focus on achieving efficiencies in business to business transactions.

Intra-organisational Electronic Commerce enables organisations to integrate function within the business. It facilitates the dissemination of information amongst work groups through e-mail, electronic bulletin boards or videoconferencing. Electronic publishing reduces the cost for printing and distributing such things as product specifications, human resource manuals and enables the faster delivery of more accurate information. And it can bring about greater sales force productivity by integrating information across marketing, production and sales. While we can see some clue in here as to the potential impact of organisational effectiveness but the emphasis is still on efficiency.

Consumer-to-business applications enable customers to learn about products through electronic publishing, to buy products with electronic cash, to authorise payments or transfers of funds electronically, obtain information on whatever is of interest to them electronically, and to communicate with other consumers via E-mail or news groups. Again a hint of effectiveness but the focus is still principally on efficiency.

From a business research perspective, the second wave has caused us to focus on the methods and tools that will enable businesses to capitalise on this new accessibility. But access of itself is not enough. The real gains will come when we learn how to best use this accessibility to change and enrich the way we work. And we rarely work as individuals. We are almost always members of teams or groups. And while there have been applications available to support group-work available for over twenty years one of the great barriers to their acceptance has been accessibility. With Web-enabled access this barrier has been lifted. People can now access their team support applications no matter the location. We will argue that these WWW enabled applications will usher in a new era of collaboration where the emphasis will be on effectiveness. However, it will be as well to first discuss group work itself, in particular distributed group or teamwork.

3 TEAM-WORK

There is no doubting an increasing use of teams in business for a variety of reasons. This trend has been in evidence for more than a decade. Back in the 80's, Mosvick and Nelson [8] identified an increasing use of teams in business for three reasons: greater use of project teams; greater use of participative management; and greater interdependence of business units. Johansen [5] says issues such as industry deregulation, outsourcing, flatter hierarchies, mergers and acquisitions and just plain greater efficiencies have contributed to the increasing use of teamwork.

With rise in business teams generally, there is of course a rise in the importance of distributed teams —teams that cannot easily meet face-to-face. The increasing geographic dispersion of companies, globalisation of companies and the rise of telecommuting are examples of this trend [5].

4 THIRD WAVE

We expect the third wave of Electronic Commerce will focus on collaborative work practices to support alliances, networks, partnerships and teamwork within and across value chain entities. This is often described as the emergence of the "virtual organisation". The term "virtual organisation" has many meanings [13]. For example it may refer to new, flexible organisational structures, or the redesign of work based on information technologies [2] [16], or new social communities [12]. For this paper we are using the term virtual organisation to imply that people are separated (by time, distance or both) while at the same time have a need or desire to work together to some common end. The phrase often used to describe this is working apart together [3] [9]. This third wave of Electronic Commerce will come about through the merging and fusing of traditional Groupware products and WWW.

5 GROUPWARE TOOLS

Groupware tools have been developing over the last thirty years. The origins are in the fields of group decision-making, computer-supported collaborative work, computer-mediated communication, and personal productivity tools. The tools that were developed in these fields are now converging into single suites of applications. They are aimed at supporting knowledge workers who find themselves having to work with others who are separated by time or distance. The range of Groupware functionality that exists today is summarised in Table 1.

6 Technology Trends

The growth and adoption of the various collaborative technologies has been slow in comparison to other applications. This appears to be changing as industry reports indicate there is strong growth in the Groupware market [19]. Lotus Notes[3] has installed base of 20 million users [7]. And to date, more than six million users have selected Novell's GroupWise[4] as their integrated e-mail, personal calendaring, group scheduling, and task management tool [4]. MS Outlook is shipped with every copy of MS Office[5].

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3 Lotus Development Corporation
4 Novell Inc
5 Microsoft Corporation

Groupware Tools and Systems	Common Functionality
Calendars and Scheduling Tools	Personal schedules; Other workers schedules; Resource scheduling; Time zone and worldwide holiday tracking; Meeting Schedulers; Determines "open" meeting times for a number of team members.
Contact Databases	Capacity to store names and addresses including staff directories; Capacity to dial numbers or send e-mail; Capacity to show persons by office location or work group.
Messaging Systems	E-mail; Voicemail; Fax; Internet chat; Audio conferencing, Video conferencing
Task and Project Management	Individual task management – reminders, alarms with capacity to cross-reference tasks to places and people; and capacity to priorities tasks; Full project planning software or links available; Assigning tasks for projects to individuals and work groups, and managing the status of these including alarms; Capacity to group messages, tasks, calendar events, meeting outputs in projects to assist managing accountabilities; Capacity to group tasks and manipulate into tasks and sub-tasks, and establish relationships (e.g. this task cannot complete until certain earlier task performed); Capacity to show incomplete items by person or project or location or other classification.
Document Management	Shared folders and documents to facilitate access among teams; Intranet access to all manuals, policies etc. at central point for ease of updating; User friendly indexing functions; Capacity to easily transfer documents from PC's/Notebooks to Public Space (drag-and-drop); Facilitate preparation of documents by multiple authors by having a centralized copy rather than many copies in circulation; Capacity to check status of documents sent for review; Allow editing and tracking multiple versions of same documents; Greater version control; Capacity to create and translate documents as HTML for ease of transfer to Web; Retrieving sites from the web, and sharing with co-workers
Asynchronous Meetings/Virtual Team Rooms	Capacity to hold meetings over time as managed conversations – use of threads, message classification (e.g. promise, request, counter offer), and project keywords; Capacity to cross-reference to Project and Document Management Tools including Brainstorming, Classification and Categorisation of issues, Voting, Weighting and Ranking, Whiteboard, On-line Survey; Facilitate scheduling and notification of meetings, tracking status of discussions etc.

Table 1 Groupware Functionality

Synchronous Meetings	Same as asynchronous meetings except capacity to converse (Chat) in same-time mode; use of whiteboards; sharing of applications and files e.g. document, spreadsheet, project plan. Fast enough to allow input and display during audio (and video) calls to allow combination with other tools.
Creation of Web-based Content	Easy for users to develop and edit their own content; easily transfer documentation to the Web and vice-versa. Easy to reference Web based content with capacity to store and reference web pages off-line
Development Access	Most packages allow the development of applications/functions specifically for each groups' requirements. This may range from developing templates for standard business processes and on-line reports through to full applications.
Accessibility	On-line and Off-line access (i.e. mobile workers can take full web pages with them); Capacity to support mobile workers (i.e. in cars, hotel rooms, airports, homes); Capacity to access other applications and other databases regardless of platforms; Capacity to access the Web; Multi-level security access available to protect servers, databases, documents and mail messages
Advanced Options	Capacity to use speech recognition as (once trained) this input format is much faster than typing

Table 1 Groupware Functionality (Cont'd)

One of the barriers to the adoption of collaborative technologies has been accessibility. So we see one of the most exciting trends is the WWW-enabled breakthrough in this regard. Many of the above tools have come about in the normal course of software evolution and have been available on corporate Local and Wide Area Networks. We believe that one of the great leaps forward for the adoption of this kind of software will be the accessibility of these tools to team members through the WWW. In the past the availability of these tools has limited their usage [18]. For example, how does a person easily update their calendar or task management from home, or on the road, and still be able to have other members of the group see the changes. With access now available through Web browsers there is likely to be huge growth in the use of these products. This we believe will be the third wave of electronic commerce.

There is also evidence of integration of personal and organisational tools.

For example, there is a move to a single point of entry for all office tools - word-processing, spreadsheets, databases, project planning, publishing tools. There is greater transparency in accessing databases as clients use a consistent front-end to access a variety of back end applications. Eventually, this could result in the integration of all tools into single packages. This is in contrast to single tools for single functions i.e. WP tool for WP, e-mail tool for e-mail, spreadsheet tools for spreadsheet work.

We see the integration trend also with PC-based tools, server-tools and the Internet. There is a single point of entry for messaging and task applications. For example, users have a single mailbox for e-mail, fax and voice-mail. Access to the web, or calendars, or document management tasks is through the same point. Integration means a common interface, which means less training. These tools are integrated even though may be working on different platforms with different operating systems. In fact many are closely integrated with operating systems giving greater transparency for users (e.g. GroupWise[6] which was developed by Novell).

These new technologies also allow the creation and maintenance of an organisational memory. Past decisions and actions can documented for later review which facilitates the evaluation process. Templates and workflow processes can be developed for recurring jobs, which prevent the wheel being invented each time a new project is taken on board. This helps create the learning organisation.

7 CHANGING THE WAY WE WORK

The potential impact of collaborative technologies is huge. With knowledge workers able to connect with co-workers and access the work resources they need anywhere and anytime, most of the restrictions on work design are eliminated. In terms of their development "life-cycle" these Web technologies are in their infancy - much akin to the very first word processors. As was the case with word processing, people, teams and organisations are discovering all kinds of new opportunities for altering the way they work through these new technologies. And, as one of our research subjects recently suggested, how do people work without them?

Just as the telephone, word processor and fax altered the way we work; the new tools will alter the way we communicate. The tools offer additional, and in some cases specialised modes, of communication. Already researchers are noting changes in the way people communicate. For example, people appear more likely to communicate messages with the potential to create conflict through computer-based mode. Computer-based communication also tends to be less hierarchical as it easy to communicate directly with the CEO or for the CEO to bypass middle management and communicate direct with the workers - often with unforeseen consequences [14]. The capacity to communicate in virtual team rooms means there is more flexibility in working hours, and location, as noted in the telecommuting trend. This in turn may lead a change away from the individual as the focus of the work unit to the team as the focus of a work unit. To some degree this may reflect what has been happening in manufacturing with quality circles. Where the team is responsible for the product and remuneration is team-based rather than individual based. Further, work will become for the good of the team rather than the individual with less tolerance for those people who are unwilling to share their information resources with others.

8 SOME ISSUES

While technology enables collaboration may lead to more effective global business processes, it also brings with it some management issues.

Effective use of collaborative technologies requires workers being willing to share with other team members, and perhaps the entire organisation review a person's work. This in turn will behoove managers to manage responsibly to create environments of trust.

Individuals will become increasingly documenters of their work. Either, implicitly through everyday messaging and correspondence, or explicitly through specialised recording systems, knowledge workers will be recording what they do. This is the

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6 Novell Inc

mechanism to utilise the team and organisational memory capabilities spoken of in technological trends.

The use of these capabilities also puts a greater emphasis on information or knowledge management. The capacity to design and develop structures for inputting, storing, processing and outputting knowledge will change. Given the amount of information held digitally it will be important to have well-developed filing systems. This may lead to an increased reliance on librarians who are likely to emerge as key personnel in managing the large amounts of information, and assisting in information overload.

Information management may evolve from being the responsibility of a few specialists to being the responsibility of all. As the IT role changed from gatekeeper of the technology (mainframe era) to partner in technology (PC era), the same will be true of information management.

Use of collaborative technologies will produce an even greater reliance on the technology. If the organisation's or teams knowledge is contained within the system, and the system is inoperable how will the team function?

These tools will re-enforce a team environment (e.g. calendaring tools, which assist in finding open meeting, times only work if everyone keeps their own calendar up-to-date; public displays of project tasks and status may lead to greater accountability).

9 CONCLUSIONS

This third wave of Electronic Commerce will come about through the merging of Web and Groupware technologies. Potentially it will allow the virtual organisation to become the dominant organisational form heralding a new era of business process effectiveness. However, while the technology progression is inevitable, there are a number of management issues to be addressed for the potential to become a reality. These issues centre on teamwork and information management.

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Telecooperation through World Wide Workflows

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Abstract

Business processes do not start or end at the boundaries of organizations. To support the participation of external agents in a workflow, the communication between workflow systems, or of a workflow system with other external IT-systems we propose a communication architecture which mainly relies on WWW-technology and the exchange of structured documents (forms). We separate the definition of a process and the assignment of agents from the communication with this agent to provide greater flexibility. We propose the use of HTML and XML forms for communication since these documents are readable for humans and are easily transformed into database records.

1. Introduction

Workflow management systems are an efficient means to increase productivity and quality of business processes. On one hand they contribute to a better documentation of processes and provide a better overview of active processes and thus allow for a more efficient managenment of business processes and improved process reporting. On the other hand, they increase throughput of processes mostly due to reduced transport times and fewer media gaps with their associated expense for multiple input of the same data.

These advantages of workflow management often end at the organizations boundaries. From business process reengineering of intra-organizational processes we learned that huge improvements can be made at the interfaces of organizational units. Therefore, we can expect that extending workflow technology to inter-organizational processes has a high potential for optimization.

The Workflow Management Coalition (WfMC) defined some ways of cooperation of workflow systems in the interface 4 of their reference architecture [7]. This cooperation is mainly technical in the sense that they provide interfaces that workflow managemt systems may exchange information. We take a diffent viewpoint here. We distinguish three different kinds of cooperations:

1. workflow participant from outside: Examples for such participants are customers for e-commerce or citizens for government agencies. This form of cooperation allows users from outside of the organization, to start a workflow, participate in a workflow by performing tasks. The user interacts with the workflow systems through a usual workflow client.

2. planned cooperation: Here the workflow systems interacts with the workflow system of a partner company. The cooperation can be preplanned, protocols for interaction are negotiated. This is the case where the interface 4 definitions of the WfMC can be helpful.

3. ad-hoc cooperation: In this type of cooperation the workflow system interacts with other workflow systems or IT systems without preplanned protocol and interfaces. Examples for such a cooperation are requesting quotes from several different vendors, answering to bids, etc. This kind of cooperation demands the employment of standards and the ability to flexibly adjust the interfaces of a workflow system.

In this paper we present an architecture to support all three kinds of cooperations. The main concepts of this architecture are:

- Separation of process definition from the way of interaction. When specifying a business process no information about the agent of a task should be necessary. The assignment of internal and external agents should be independent of the form of communication. The possible communcation channels should be chosen then with the help of the organizational model.

- Reduction of the assumptions about cooperation partners as much as possible. We want to make as little assumptions about cooopeartion partners as possible. For external human participants we only assume that they have access to a web browser. For IT systems we only assume that they can send and receive forms.

- Employment of communication standards as much as possible. In particular, we rely mainly on Web-technology and the EDIFACT standard for structured documents.

- Integration of different kinds of interaction in a uniform way.

In this paper we discuss different forms of interaction and show the communication architecture to support them. We introduce a model for maintaining information about external workflow participants and collaboration partners. We present the process definition language and the form interface, and finally we draw some conclusions.

2. Interactions

The platform of choice for electronic interaction between enterprises is the Internet with the popular services e-mail, ftp and WWW. Especially the latter has become very popular for accessing information and most workflow vendors built interfaces of their products to the Web. The services of the Internet can be used to support all steps of a business process:

Advertising: The seller of goods or services can provide information on Web pages, or mail potential customers directly. Interested persons find the Web sites by using a search engine or following a link.

Initialization: After a customer has found a supplier (or vice versa) a business process can be initialized: the customer initializes the process by making a request (for quote, for information, ...) or placing an order. Using the Internet, this can be done via a HTTP [1] form submission, the customer interacts with an application on the Web server of the supplier and is guided for providing the necessary information for initializing a process.

Cooperation: After initialization the business process normally contains further interaction between the partners: gathering additional information, bargaining, arrange delivery and payment conditions, and payment.

Monitoring: Customers should have the possibility to monitor the forthcoming of the process (a popular example of such functionality is the possibility to track the state of Federal Express packets, http://www.fedex.com/track_it.html).

The workflow management systems must be able to support cooperation of the above types and with different kinds of partners at various levels of integration. The workflow participants can be distinguished in:

1. **The occasional user**: The typical partner in non business-to-business electronic commerce. We can not expect any special software installed on his client and have to rely on the minimal requirements, someone has to fulfill to participate on electronic commerce:
   - Internet access,
   - receive and send electronic mail,
   - Web browser with HTML forms.

   Examples for this type of customers are people buying things over the Internet or performing electronic banking. The introduction of encryption of information via secure socket layer (SSL) allows the usage of this form of interaction for confidential information.
   Allowing all types of interaction (initialization, collaboration, and monitoring) the wfms must have a HTML interface providing this functionality. The notification of users about new tasks or other changes in the process can be done via e-mail. Fig. 1 shows the basic blocks of the architecture.

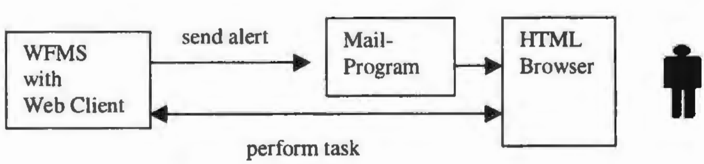

Fig. 1 Interaction with Web Client

With the increasing power of standard Web browsers (HTML4, dynamic HTML, Java Applets) this simplest form of interaction gains increasing popularity in other interaction scenarios:

2. **Frequent users** of the system where it is not possible or feasible to install special-purpose software on the clients may use the Web Client. Consider for example doctors communicating with a hospital exchanging information about clients.

3. **Mobile users:** The third category of participants are employees from the organization connecting to the business process from the Internet, because they are on a business trip or teleworkers. The system architecture is the same again, the differences lay in the rights of the participants. From the customer, who is only allowed to see the business processes he is participating in (and from these only some restricted information, for example not all documents or not all other participants) to the manager on business trip who can monitor the processes of the whole department may work with the Web client.

   Providing a uniform user interface for people outside and inside the organization leads to great flexibility and reflects the structure of modern organizations where work is performed in highly decentralized networks of shifting project teams (this forms of organizations have been called ***adhocracies***, [4]).

   One main advantage of this type of realization – no installation on the client – results in the main disadvantage: The client application has no access to local files or other resources. The whole interaction must therefore be done online. Signed Applets would provide a technical solution but the acceptance from the occasional user – giving away the right to write on the local disk - might be low.

4. The next category of users are **partners in other organizations:** Technically, they fulfill the same requirements as the above clients. The difference is, that they may have their own system installed, wanting to use one client for communicating with many other systems. The architecture is shown in Fig. 2.

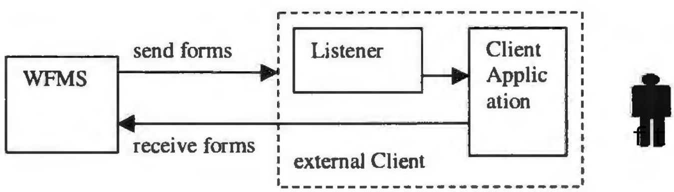

Fig. 2 Communication with external client

The presence of a special client allows downloading the information of the workflow and working offline. The communication is done via exchanging forms: when interaction is required the wfms sends the forms to the client, after performing the task the client sends back the form to the wfms.

Monitoring running processes is also performed via exchanging forms, a request for information is sent to the wfms, which sends back the answer form. Additionaly, the monitoring function of the Web client can be used.

5. The previous cases assumed a user communicating with a workflow system. Business-to-business e-commerce requires the communication of workflow systems. Fig. 3 shows the principal architecture, again using sending and receiving forms as communication mechanism.

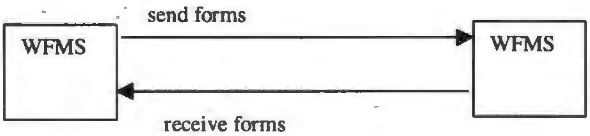

Fig. 3 Communication between workflow systems

Having to deal with this variety of clients and interfaces the challange is to provide a uniform architecture where the definition and execution of processes is done independently of the type of participants.

3. Maintaining organizations and people

A first step making the workflow system communicating with others is the representation of all participating agents in the workflow system. The following entities are maintained:

- *Roles*: Agents have roles, representing the type of job (secretary, manager, ...) or some skills (Java-programmer). Using roles as agents in process definitions make these definitions independent of particular persons.

- *Organizational hierarchy*: Not only the internal hierarchy should be represented but also the structure of the partner organizations. This allows to communicate with specific roles in specific departments, for example sending information to the clerk in the purchase department of an organization.
- *Persons*: Everybody, who participates in a business process has an entry into the person table. This gives the system a unique identifier and assigns some default rights or roles to the person. The following information is stored about persons.
  - *rights*: what may the agent do and see: his own worklist, the history of processes (full or condensed), the worklists of other persons of the same department, etc.
  - *address*: e-mail address, fax number, postal address, or HTTP URL may be possible entries in the address fields.
  - *client-type*: specifies in what form the tasks will be delivered: as links to the HTML client or as folder of forms.

The emerging directory of organizations and people will be useful for other purposes too and may be a component of the wfms or an integrated application.

4. Process definition

The definition of a workflow consist of three parts: the definition of the individual tasks, the definition of the sequence, and the types of data used in the process. In the following we use WDL (Workflow Description Language), the script language for describing workflows of the wfms Panta Rhei [2] for our examples. WDL defines the structure of the steps in the workflow using control structures for loops, branches, and parallelism. Every such step specifies *who* does *what* with *which data*, for example:

```
sek make_approval(application);
```

This step defines that the role `sek` performs the task `make_approval` using the form `application`. The agent of a task can be either a user, a role, an organizational unit, the agent of a previous task, or the value of a form field. This form of dynamic agent assignment allows the specification of ad-hoc tasks. The definition of tasks in WDL contains the specification of a post-condition, a maximum execution time, or a program, if the activity is executed automatically. The form arguments can have the modes in, inout, and out, indicating whether the form is an input form, an input and output form (will be changed in the task) or an output form (gererated in the task). The following example shows the definition of a simple order process:

```
process order_proc()
forms req recquote,
      order order_form,
      quote quote_form;
      invoic invoice;

begin
  all make_request(req) first;
  req.company request_quotes(req, quote);
  first:user check_quote(quote, order);
  order.company make_order(order);
  order.company make_invoice(invoic);
  sec pay(invoice);
end;
```

After the header with the process name the forms used in this process are defined as pairs specifying the form name followed by the form type.

In the first task the anybody (role **all**) can make a request and fill in the request form. The token first is a label used for referencing this step later. As agent of the next task a form-field is specified, the company field of the request form. If this field contains a reference to an external agent, the task is executed outside the organization. The task **request_quotes** must be defined with one input form, the request for the quote, and an output form, the quote. In the execution the process will send the input form to the company (the input to the remote task) and wait until the output form is received. In the next task the user of the first task has the possibility to check the received quote and fill in the order, which is delivered in the next step. The following task, make_invoice is again executed on the remote system: It has only an output form, so the process will wait until this form is received. The monitoring component will report this status of the process, allowing the business partner to see what is expected at this point. In the last step the sec[retary] pays the invoice.

Also part of the process specification is the interface definition, indicating what type of process is started when a form of a particular type is received. For example, forms of type order will start a selling process.

In the process definition we make no distinction between local and non-local agents or between the types of clients the agents use. However, the workflow engine interpreting the process definition must distinguish between the different agent types and act accordingly.

5. How the wfms interprets non-local agents

When the workflow engine starts a new task and assigns an agent to it, the following procedure is started:

> **if** *agent is extern* **then**
>   **case** *type of address and client is:*
>   *email, online:* send an email alert with links to the HTML-client;
>   *HTTP-address:* put the forms in a folder and make file upload;
>   *email, offline:* put the forms in an email and send;
>   *fax:* make image from forms content and send;
>   *letter:* put content image in worklist of secretary;
>   **end case**
> **end if**

Briefly, there are two possibilities: send the forms or send an alert message containing a link to the HTML-interface. Accordingly, the task is finished in two ways:

- the worklist client finishes the task: this is the case for internal users and external users working with the HTML interface.
- The task is finished, when the wfms receives the forms of a task handled externally.

The reaction of a wfms on receiving of forms is shown in the following algorithm:

> **if** *the forms belong to a running process* **then**
>   **if** *the process is waiting for these forms* **then**
>   continue process
>   **else** exception1
> **end if**
> **else if** *interface defined for these forms* **then**
>   start new process
>   **else** exception2
>   **end if**
> **end if**

When the received forms belong to a running process the process is continued, otherwise a new process is initialized. When a form is received, for which no process is defined, or which is unknown, an exception is thrown. The normal handling of such an exception would be to start a new default process where some default recipients get these forms in the worklist.

The functionality of the wfms is the one side of the interaction, on the other side the client must also act accordingly:

1. The Web client is started following a link in a notification email. Because the user works interactive this client uses the same wfms API as other user interface clients.
2. The offline client must have the following functionality:
   - receive a form folder,
   - show the process and task information,
   - allow editing of the forms,
   - send the forms when the task is finished.

As transport mechanism for sending forms to the offline client, either email or HTTP would be possible.

6. Form mapping

The communication via forms anticipates that the organizations use standardized forms. When communicating with a customer via the Web client, proprietary forms could be used. Also when using the offline client – the form description can be sent together with the forms. But communication between different wfmss, where the process execution can be controlled by the form content, a standardization is necessary. A good choice would be the EDIFACT standard of the United Nations [6], which defines the structure of several dozens of messages for electronic commerce. Examples are request for quote (RECQUOTE), request for reservation (RESREQ) or invoice message (INVOIC).

However, EDIFACT documents have a severe drawback, they are well suited for ordering thousand windscreens but nobody wants to use them when ordering a book or a pizza. For such cases a form mapping procedure must be defined, mapping the fields of proprietary forms to the fields of EDIFACT forms and vice versa.

7. Conclusions

IT-support for performing business processes should not end at organizational boundaries. We proposed a system for telecooperation which realizes communication and cooperation with different kinds of external partners in a uniform way. Core of our system is the usage of a form-exchange

Telecooperation and the Need for Informational Guarantees

Herbert Fiedler

Telecooperation presupposes secure, reliable Telecommunication infrastructures within legal frameworks. Traditionally (in Europe), informational guarantees have been provided by a constellation of state-owned telecommunication systems and legal regulations on data privacy and security. With privatization of telecommunication systems (in the 80ies and 90ies; in Germany "Postreform") this situation has fundamentally changed. Also, the paradigm of the social role of information processing has changed: Since the advent of personal computing (in the early 80ies) information technology is no longer an exotic, exclusive instrument in the hands of a few (government, big business) - but a technology for anybody. Available for anybody has also become computer - supported cryptography, which is one of the bases for an extended functionality of data security. Therewith, the "stealth" - technology of intelligence services has become available to anyone - making possible confidential and unobservable communication and even transactions for everyone. There are strong tendencies to deny national states any influence and control on the use of computer - supported cryptography. The new question arising then, is: Are national states going to be informationally disabled? (A scenario complementary to Orwell's "1984"). What complementary informational guarantees have to be developed to safeguard a stable situation for telecommunication and telecooperation?

1. Telecooperation and Telecommunication

Telecooperation is a subject emerging rather late among the different fields of information processing. Telecooperation presupposes a variety of more traditional methods and instruments of information processing - and in addition an environment of secure and reliable telecommunication infrastructures. The relevant traditional methods and instruments of information processing are fairly well known already - although they are still developing rapidly. They comprise, e.g., methods and instruments of information management, workflow management and group cooperation (CSCW, groupware). The more critical issues regard the environment of secure and reliable telecommunication infrastructures - at least, if telecooperation has to take place in open systems. Telecommunication in open systems is the field of information processing, which has undergone the most rapid development and the most relevant changes in our times.

Will it be possible to give guarantees for the necessary functioning of telecommunication for telecooperation? What functions are there comprised, and what guarantees can there be given (eventually for a global environment)? In what relation to more traditional guarantees for the functions of information processing are they to be seen? What methods and actors can contribute to such guarantees? What consequences (also in other fields than telecommunication and telecooperation) are to be expected? These are some of the questions to be addressed - but surely not to be completely answered here.

2. Data Security and Data Privacy: Different lines of Informational Guarantees

Since the advent of applied information processing it has been realized, that applications of information processing imply certain dangers as well as necessitate corresponding protection measures. Among the most prominent apprehensions were those regarding

- dangers for information processing itself, its systems, providers and users
- dangers for persons, whose personal data are processed

The corresponding protection measures have been later classified under the headings

- data security
- data privacy.

A confusing terminology (emanating from Germany) has also developed: Naming data privacy as "Datenschutz" (literally translated, "data protection" - applicable also to data security and at first glance primarily implying this subject).

Data security (or information processing security) is a requirement connected quite naturally with any application of data processing. In the early times of information processing, it has sometimes been specifically associated with the security of classified information processed by government agencies. The postulates of data privacy, on the other hand, originated in the U.S. from modern legal tradition ("right to be left alone"). Sometimes, it has been associated with movements in favour of civil liberties - directed against an allegedly mischievous state. World-wide (and especially in Germany) it has gained considerable momentum through Orwell's "1984". From these quarters, information processing often has been identified with an instrument of "big brother".

The lines of development of data privacy and data security have been quite different and largely without connection (as viewed with the background of Europe and especially Germany):

- Data privacy with its guarantees has been made the subject of elaborate legal regulations, imposing heavy duties on the users of information processing for the benefit of the persons, whose data are processed (statutes on data privacy, "Datenschutzgesetze"). Measures of data security have been included, insofar as they support the aims of data privacy.

- Data security, on the other hand, by the legislator largely has been left to the discretion of providers and users of information processing. Of course, they may incur liabilities according to general law (not specific for information processing). A parallel to the law of data privacy, however, is lacking - which would impose specific duties of security on providers and users of information processing for the benefit of e.g. their customers. An exception from this liberality, however, is emerging in the field of telecommunications.

- Data security for telecommunications (in Europe) hardly had been noted as a special problem as long as the infrastructure of telecommimications had been part of the organization of national states. These have been deemed responsible for an overall reliability and security of telecommunications - and have been credited for the will and power to comply with their responsibility. This situation has changed dramatically with the liberalization of telecommunication in Europe in the 80ies and 90ies (in Germany: "Postreform"). Telecommunication infrastructure now is no longer part of the organization of the states, but a business of private enterprise. In Germany (speaking grossly) telecommunication providers now have to be licensed by government regulatory bodies and have to fulfill special legal requirements of data security (and data privacy). In Germany, a special statute law for telecommunication has developed, comprising also requirements and duties for data security (esp. "Telekommunikationsgesetz", "TKG", and herein esp. ¤ 87).

One might call the requirements of data security, data privacy and the safeguards for their fulfillment "informational guarantees" for the benefit of the citizens as well as the national states (or vice versa; it is one of our main contentions here, that these two are inseparably linked). The somewhat awkward term "informational" here is a literal translation of a terminology invented by the german supreme constitutional court ("Informationelle" Selbstbestimmung).

3. The need for a system of coherent informational guarantees

During the time of development of legal regulations for data privacy and data security, from the quarters of informatics the concepts and instruments of data security have been expanded to form an important sub-discipline. In the beginning, data security may have been viewed mainly as the requirement of data confidentiality for the users of information processing. This corresponds to an early phase of information processing as an exclusive instrument mainly for government agencies. Since then, from informatics the functionality of data security has been conceived very much broader, to comprise e.g.

- confidentiality
- reliability
- integrity
- identification
- authentication
- non - refutability
- possible anonymity and pseudonymity in certain environments.

Combinations of such functions within appropriate organizational settings are the base of more complex functions and services, like key management, key recovery, electronic signatures. These in turn are essential for applications in electronic commerce, electronic law enforcement, etc.

The beneficiaries of these functions are not only the users of information processing, but also other persons and organizations, whose rights and interests are concerned. The first steps, of course, were descriptions (and eventually definitions) of this extended functionality. Subsequent steps were the development of

- means to implement it and safeguard its applications (to a considerable extent based on cryptographic methods)
- criteria and certification procedures for its fulfillment.

Relevant standards and norms are in the process of development.

In this process of informatic-driven developments the national states (and their alliances) entered again to harmonize e.g. the relevant criteria (e.g. ITSEC; Common Criteria ...). This harmonization is urgently required for international compatibility and exchange. Despite the international scope, the foundations for e.g. certification bodies were to be laid in the national states.

However, all these developments of data security have taken place independently of the former developments of information privacy, their legal regulations and their specific security requirements. For the field of informational guarantees as a whole, therefore, there has to be deplored an incoherent state of development.

Arising from this situation, there is the problem of integrating the different lines of data privacy and security regulations and conceptions from informatics. The interrelations between these lines are very involved and have been hardly addressed from a comprehensive view. The different requirements and postulates obviously are in part contradicting each other (e.g., data privacy and the necessity of complete documentation of individual interactions for the sake of data security and its auditing).

Therefore, there is emerging the need for a system of coherent informational guarantees. For Germany, related questions have been raised long ago - with the specifically german background of a problematic doctrine of the german supreme constitutional court ("Informationelles Selbstbestimmungsrecht", Right of informational self-determination). I may here refer to my own publication (1). However, for the present international context it has to be stressed that the necessary telecommunication infrastructure presupposes the solution of fundamentally new problems.

4 Changing Paradigms of Information Processing and its Role in Society

In its beginnings, computing machinery had been an exotic, extremely expensive and exclusive instrument, available only to a few technically leading nations. Its applications (apart from research) largely had been a prerogative of state governments. Prominent fields of early applications had been e.g. the military and intelligence services. From these quarters also originated one of the most important techniques of modern computing: The computer - supported version of the old "black art" of cryptography (encryption / deciphering). To this situation corresponds the traditional paradigm of the social role of information processing: An exotic, intransparent technology exclusively in the hands of state governments and big business. This image has been the background of early conceptions of data security, and, primarily, data privacy:

- data security as the protection of confidentiality for the privileged users of information processing
- data privacy as the protection of citizens against the doings of allegedly mischievous governments (Orwell, "1984"; movements of civil liberties).

The remnants of this old paradigm (information processing as an exotie technology exclusively in the hands of state governments and big business) have prevailed up till now, especially among the partisans of data privacy - although it has become obsolete sinee long.

The traditional paradigm of the social role of information processing has become obsolete with the advent of personal computing in the early 80ies at the latest. Since then, information processing is no more an exotie, exelusive instrument of the few (governments, ete.) but a technology available! for anyone. (In parentheses: Though not for everyone; not for the underprivileged like the poor, people handicapped by poor education, old age, etc.). At present, information processing has become a technology for anybody and a foundation of our way of life. Aecording to this role, information proeessing is needing protection as well as is implying dangers in a new way.

Very important is the fact, that with personal computing also the "black art" of computer - supported cryptography has become available for anybody. Cryptographic methods are a part of broadly available software systems to support an extended functionality of data security (and, consequently, data privaey). This fact is relevant espeeially for telecommunication in open systems. With certain provisions, anybody has the means to communicate confidentially (and even unobservably) with any partner of his / her choice. That is to say, that the former "stealth" - technology of governments and intelligence services has become available for anyone.

Thereby, the traditional casting of roles between information processing of state governments and information processing of individuals (and their organizations) in part has been reversed:

The infrastructure of telecommunication (in Europe) is no longer part of state organizations, but a business of private enterprise. Also the use of computer - supported cryptography is no longer a prerogative of governments. On the contrary, any regulatory power of governments for the use of cryptography nowadays is being disputed. The use of "key escrow" or "key recovery" methods in favour of government agencies (e.g. for law enforcement) often is being disapproved. Even the legitimaey of restrictive legislation on cryptography is questioned with arguments from constitutions. On these issues, a heated international debate is going on. The arguments against any influence and control of national states and their agencies on the use of computer - supported cryptography are coming from very different quarters: Civil liberty movements as well as big business, forming here a strange allianee.

Therefore, under the new paradigm of information processing there are emerging strong trends to disable national states in the digital - informational sphere. These trends are not so much originating from the development of information processing itsellf. They are rather a result of social reactions appropriate to the traditional paradigm of information processing, unwittingly carried on into an environment, which has fundamentally changed.

In this situation, a lot of new questions are arising:

- How will the national states longer be able to enforce informational guarantees?
- Who (if not the national states) will be willing to protect the interests of informationally underprivileged people?
- Who is to safeguard the infrastructures of democracy (hitherto the obligation of national states and not yet transferred to other organizations)?
- How will the national states and governments be able to provide transparently basic functions for supranational infrastructures (e.g. trust center, certification agencies,...)?

5 Informational guarantees, law and state: New Prerequisites for Telecommunication and Telecooperation

Under the new paradigm of information processing (technology for anybody) informatics has developed instruments for the self-protection of individuals. Insofar individuals and private organizations today may reap the fruits of guaranteed information security and privacy. The (hidden) precondition, however, is the stability of our present informational environment - including instances like the national states. Under the traditional paradigm of information processing the main apprehension had been the hypertrophy of a mischievous state (Orwell's "1984"). But what will result, if (under the new paradigm) the power of informationally disabled states will vanish altogether? This development seems possible, if states do not retain a certain control of computer - supported cryptography (and its parallels and derivates). These will be essential for the digital - informational sphere and all life in an "information society".

The result might not be free exchange in a happy anarchic global village - but rather a topography of power with a background of chaos, without all the guarantees of transparency and balance of powers characteristic for modern states. This scenario is a complement to the scenario "1984". It is not so very much far-fetched, considering the global trends for the privatization of national states.

Considering this complementary scenario, there are good reasons to demand complements to the traditional informational guarantees also. Supplementing the traditional guarantees of data security and data privacy for individuals, there are required guarantees of transparency and the possibility of external control by public agencies. Such agencies are especially national states and governments (later on also transnational agencies, when there is a stable democratic infrastructure). The purpose is especially law enforcement in the digital - informational sphere. That means not only prosecution and prevention of crime, but (e.g. for telecooperation) enforcement of labour law, law on free competition, etc.

The means and instruments may comprise legal regulations on the use of computer - supported) cryptographic services and especially on digital signatures, key escrow and key recovery. Of course, all such measures (limiting e.g. the guarantees of data privacy for individuals) in their turn have to be strictly constitutional. The emerging great and difficult task is the shaping of a system of coherent informational guarantees - limiting each other, incorporating not only traditional information security and privacy of individuals, but also the informational preconditions for democratic communities.

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Panel

Electronic Government: Anticipating the Tide of Change

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Electronic Government: Anticipating the Tide of Change
Position Paper for the TELECOOPERATION Conference
IFIP World Computer Congress '98

by

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The Government will become a service unlike that exists today. It will be a new notion derived from today's multimedia, virtual reality, distance learning, and telepresence concepts. This briefing will address why the government system must change and how we, in Hungary, think about the avenues to the future and changes to be initiated.

Why present Government system must change?

In general the government systems must respond to changes encompassing three current and future issues:

- The exploding technological and informational environment
- Evolving civil servants and citizens characteristics
- Continued fiscal constrains

Emerging technologies

Current trends in technology indicate that the technological fields of futire will tremendously fertile and highly affordable. For instance, comparing the 64 KRAM of the early computers of 80s with the top line desktops of today, we have seen more than 4000 fold increase in computer memory. Some experts cite a declining computing capacity price between 30-85 percent per year. If we just take a conservative rate of 50 percent, for $5000 in 2020 we should look at the capacity that $655 million could buy today. Industry experts agree that the governments and their citizens will have plenty of computing power for whatever it may dream up. Many systems are now on line to assure instant access with other people and systems around the globe. Telecommunication companies planning to provide a high level of connectivity were recognising the potential business in this area.

Challenges of Technological Environment

Since the rate of change in technology and the rate of growth in available information increase every day, all technological advances mean that by the turn of the century information demand will grow exponentially and the amount of information will be astronomicall. Without carefull planning and information handling skills, the decision-makers of the future will be paralysed of information analysis. Modem government service increasingly depends on technology and information and uses them as power and service multiplier.

Personnel Attributes

Just as the technological environment will differ, the characteristics of civil servants and citizens will be significantly different than they are today. First, there will be fewer civil servants of all positions. Accordingly the impact on the government services of the increased demand for individual treatment will be greater because of the increasing number of challenges of the individual. Civil servants will be more comprehensively trained less specialised and will have to cycle back through school often during their careers.

Fiscal constraints increase

Since there is a continuing government budget deficit, the administration must change to meet current and respond to future fiscal constraints. Administration budgets raised in order to meet international standards, however they will continue to get smaller in the future. In particular fiscal constraints will continue to impact the number of civil servants and the organisation of the administration. As the government appropriation tracks downward, cost for the technology is falling. Therefore fiscal constrains will mean increased use of technology to cover for personnel whose jobs have been automated or eliminated. Technology means increased level of education, and the trends in development of technology will call for broader range of skills. As in all new ideas and changes from long-held beliefs and ways of doing things there will be hurdles to overcome before we can successfully implement a new system. The cost is considered as the most significant obstacle to implementing the electronic government applications. We have seen the technology will be more user friendly and affordable. Another concern is the belief that the electronic administration takes away from personal contact However without the existence of virtual reality, current coinnectivity in the world has already demonstrated that interactive communication through electronic means may lead to even greater opeinness and understanding than face-to-face communication.

How we, in Hungary, think about these changes to be done? What shall we do?

The Information Technology market grows over one fifth every year. The traffic over the Internet triples every year. Telecommunication companies provide a high level of coinnectivity.

In response to the challenging environment we, in Hungary, have a National Information Strategy, which includes using information technology in government services. We have electronic banking system, tax, duties, land- and company registration data are electronically processed. The legislative power and the executive power both have its own electronic information exchange system. Thinking about the future we launched the Schoolnet project to coinnect each secondary school to the Internet, and provide them with connectivity to information resources. There is a development of the on step office service system for simplification of the government administration.

Looking toward the future:

Information Technology will remarkably expand quantity and quality of information resources in government: This manifest itself in the collaborative use of the state information, which will lead us to the system of electronic documents and Information utilities. The utilities are pay services for the citizens offering administration, registration, taxation, customs and statistical and electronic maps containing the individually desired data. Utilities will be available to the citizens and to local governments, as well that will provide all extension to data of local relevance.

The electronic management of government activities is the next step. This will include legislation aids to harmonise each aspects of enacting work and a government financial management system in correspondence of the government electronic administration system.

To efficiently use government resources information should be shared with other governments and non-government institutions.

The tide is up. Traditions could be considered but challenges and requirements do not count on if we fail to take the steps now.

Information and decision support system for local governments

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Abstract: *This paper describes briefly two kinds of information systems used in local government: financial decision support systems and citizens advisory systems. This description is based on the author's observations of about fourty french towns from the 1985 to the 1997 period. Some caveats on the use of these technologies are made.*

Two main categories of information and decision support systems are used by local government: systems whose purpose is to help to manage the financial and administrative problems of the town or the region and systems whose goal is to provide services to the citizens. The first category is relatively well known and uses technologies such as Financial Decision Support Systems and data base systems. The second, more recent, relies on access to information of interest to the citizens from interactive kiosks located in public buildings or from their homes through the use of PCs connected to INTERNET.

1. Decision Support Systems for the financial management of local government.

French local government has started to use computers, like private firms before them, for data processing applications (accounting, management of electoral lists, budget accounting as required by french law,..;) and for technical applications, often geographical information systems (computarisation of land registers, of public services networks,..;). Their interest for information systems to support local government management is more recent and dates from the early 80's.
This interest is the result of the conjunction of several factors. On one hand there were the decentralisation laws of 1982 which gave greater autonomy of management to regions and municipalities. On the other hand there was also a better understanding of the need for more rigourous management by the professionnal staff such as the administrative and financial managers and the town clerk responsable for the municipalities.
In the field of banking , a certain number of incidents some of which have become well known, have shown the need for a better use of tools in the analysis of financial and economic information concerning local government. For banks it has not been possible for a long time now to consider loans to local governments as risk free. The more so as towns have often created numerous peripheral organisations : mixed private and public organisations, low rent council housing, housing associations,...with which they have financial relationships (loans, guarantees). The consequence of this is that the lender risk is often much higher than it seems at first sight.
As far as the citizens are concerned the increased weight of local taxes has led to a more critical appraisal of the economic reasoning of local governments and the cost of public services.
Some factors delayed the equipping of local government with information systems to support the elected council or the professionnal staff. For a long time financial and managerial culture was not common as opposed to an administrative and legal culture. The elected councils came to see the advantages of such systems very late, and then only because it could help them implement their political decisions, improve transparency and management efficiency . It has always been possible to

observe a clear reticence to the transparency of accounting and financial information by many elected persons in spite of the law which confirms the public character of this kind of information.
Two recent events could change this situation in France. As from the 1st of January 1997 the M14 accounting plan has become compulsory in more than 36000 towns and in about 15000 public intercouncil organisations and in thousands of other public organisations. Also a more strict control of the accounting and use of public funds by public and para-public organisations has been enforced, even if many people consider, perhaps rightly, that this control is insufficient. The weakness of the means given to the "Public Accounts Supervisory Boards" (Cours Régionale des Comptes) prevent them from examining in good time the accounts and most of the time deprives their comments of any legal sanction.
The M14 accounting plan when applied to the main accounting information system of local government marks a significant progress to the previous one (M12). Apart from the changes in the acounting layout inspired by the general accounting plan used in private companies, it obliges local governments of more than 3500 inhabitants to abide by the accounting principle which tie expenses and revenues to the period during which they occured and to account for depreciation of renewable goods and to make use of financial provisions. The M14 accounting plan makes it compulsory to mention any balance sheet guarantees and also bring greater transparency to the allocation of operating income . It also introduces for the first time a "patrimonial" point of view to local government management. It is now possible to speak of the income statement and balance sheet of a local government. As a consequence this reform allows easier access to the financial information of local governments. This applies equaly to the members of the city council and the citizens as the other partners of the local government (bankers, suppliers, concessionaires, tenant-farmers,..;)

2. Decision Support Systems for financial management.

We shall now briefly describe the financial decision support systems which are commonly used by local governments in France when the town has more than 10 000 inhabitants. These systems support decisions dealing with :
- financial analysis and planing
- resource allocation to projects
- debt management
- analysis and reporting of external financial risk

This information relies on a sample of about 45 towns with a population ranging from 10 000 to 400 000 inhabitants which we have followed over a period of more than ten years. On the basis of this sample the financial analysis and reporting system as well as the debt management system were observed almost systematically . The resource allocation system was observed several times as well as the external risk management system. The reader interested can refer to Klein (1993) for further discussion .
We do not mention here the accounting and budget management system M14 which is a transaction oriented system. This system can be used as a data feeder to the above mentioned systems but is not directly useful for decision support.

2.1 Financial analysis and planning.

In a local government such a system is required for reporting performance concerning :debt, fiscal pressure,financial balance,etc...across time as well as across other local governments of the same type as well as numbers of inhabitants. The other function of such a system is to compute the consequences of the three main policies of a local government : the investment and infrastructure projects, the fiscal policy (which determines the level of fiscal income for the local government), the

financing policy. This decision support system is the more essential in that (in the french context) certain rules of financial and fiscal balance must be fulfilled by law.
This type of system enables the financial managers to answer questions raised by the elected body such that as:
- can investment and major works planned by the elected council be financed and still fulfill the legal constraints of financial balance and of a sound financial management. (The budget must be voted balanced but only for the year ahead) ?
- how to maintain a financial balance in the hypotheses that the income from certain taxes will be reduced (this was often the case during these years of economic decline) ?
- what is the impact on our loan portfolio of the present base interest rate evolution and which decisions have to be taken to renegotiate our debt ?

2.2 Debt management.

The local government financial planning requires knowledge of the yearly depreciation schedule (capital and interest) of the local government debt. The same depreciation schedule is needed on a monthly basis for the monthly cash management. This problem, fairly simple in a private company, is unsolvable in the french context of a local government. French law requires that a local government when it makes a loan indicates for which investment or major work the loan is made.The consequence of this requirement is a multiplicity of loans. One can observe 50 to 75 loans in a local government of 10 000 inhabitants. The problem is in fact more complex since local governments use a wide variety of fixed and variable interest loans, for some loans the capital is reimbursed in one lump sum at the end of the loan (with consequences which can be very dangerous !). Such a system must allow for the simulation of the renegotiation of the debt of the local government as well as the impact on the global debt schedule of a new long term loan
With respect to short term debt, in spite of the obligation to keep any extra cash on account with the public treasurer with a fixed interest which limits the possibility of the local government, a decision support system is therefore needed to use the credit lines available with the banks efficiently.

2.3 Resources allocation and project management.

Experience shows that one of the essential aspects of local government management is the choice of investment and main work. In private sector organisations, if financial theory cannot be of any help to select the viable projects, it is nevertheless a guide to allocate funds once the project has been defined. The choice of a viable project is a question of strategy and not of finance. A decision support system for resources allocation and project management can be used to support the study of and find solution for two important questions : computing the impact on the global financial balance of projects over time and the impact of new projects. We speak here of projects whose importance justifies studying their impact individually. To such a project can be associated an initial investment^ and cash inflows (for example increase in future taxes) and outflows (operating costs). The system goal is to manage the data related to the portfolio of projects of the local government. It means allowing the data capture of the financial and economic characteristics of projects over their expected life or at least the planning horizon. The computation of cash inflows and outflows and their return. It is also possible to associate with the projects other important criteria such as the number of jobs created, or a measure of their interest for the elected council. Sorting the project using these criteria becomes possible. The most appreciated usage of such a system is when it is related to the financial analysis and planning system. If such a link exists it is possible to select one or several projects in the portfolio of considered projects and visualise their impact on various criteria. (financial balance, fiscal burden, level of service to the inhabitants,...). The reallocation of projects over time may lead the elected body to accept more than what was previously planned. It can also show that it is possible to use remaining borrowing capacity to accept a new project. It can also be used to measure the decrease in fiscal burden that abandonning the project could lead to. Some example of the use of such systems in local government meetings have been observed in our sample. One main point is to present to members of the council with the consequences of various alternatives.

3. Citizens Advisory systems.

The goal of CAS is to provide the citizens with clear and easily accessible information concerning the services which they are entitled to obtain from the administration. This information would include the administrative forms they may require and their rights and duties. These systems can be used from kiosks within the buildings of local governments and mainly from PCs connected to the local government web site . The official goal of these systems is to contribute to :
- transparency and efficiency of public services
- promotion of democracy
- better knowledge for the citizens of their rights and administrative duties.

Several systems of this kinds have started to be offered by french and other european cities under the form of a web site. If we consider the CATCH system described by Stuchlik (1997) which is the result of a research contract with the EC, such a system can access in an hypertex mode information concerning :
- emergency services (doctors, hospital, police, fire brigade,..;)
- public services of the town (election, dates and agenda of the council, building permits, local taxes,..;)
- public services of the central governments (fiscal services, fiscal forms, passports, ID cards, driving licences,..;)
- cultural events
- jobs offers and support to the jobless
- social services
- economic activity (concerning companies which are situated within the council boundaries)
- tourist office
- health (information on health services,..;)
- environment

etc...

This information can be accessed using key words or from a home page of a web site using an hypertext mode. These types of system have been extended to the supply of admistrative forms and to access financial information concerning the local government . In fact most financial information offered this way concern major items of the budget and never the cost of public services. It is also clear that it is not difficult from a technical point of view to use such systems to collect votes on projects. Theoreticaly it is possible to ask the opinion of citizens more often.

4. Concerning the proper use of such systems.

First of all we personaly believe that Citizen Advisory Systems are going to develop faster in local governments than financial decision support systems. The image of the elected body has far more to gain from the implementation of a web site which gives an image of modernism than from the use of DSS which is of interest to a smaller number of people . Let us examin the arguments advocated by proponents of these systems.

With respect to transparency and efficiency of public services it must be possible that access to such services be available by all citizens and be requested by them rather than having it imposed upon them. The adoption process of innovations of such applications using a PC connected to INTERNET is a social process.There is no reason why all citizens should wish to obtain this information through a computer. Many may legitimately wish to go on obtaining this information through direct contact with a human being. One should keep in mind that these new services necessitate having a PC, a modem and an INTERNET connection . The cost of this equipment could keep some citizens away from important information since all citizens cannot afford it. The problem is then how to give acces to all citizens to such services so that no one is advantaged or disadvantaged for reasons which are not fair.

With respect to the development of democracy we share the idea that everything which contributes to increase the transparency of the costs of public services improves it. In the same way more reliable information concerning citizens preferences for local governmennt projects also improves democracy .

The problem is that this aim will be reached as the consequence of a political will and not by mere technology. If the elected council still thinks that it is not in its best interest to make information easily available on its agreements with outside organisations as well as the cost of the town public services there is no reason that this will improve democracy . This could on the contrary be a way for the elected body to give biased information to the citizens.

We believe that the most important problem is to create a sense of civic responsibility with the citizens and to incite them to request reliable information to direct their choice on important decisions . For example deciding on a new public service with relation to an increase of the tax burden. With respect to the problem of electronic voting it does not raise difficult technical problems.The real problems are related to preference aggregation when citizens are requested to rank projects. The interested reader is refered to Arrow (1951) and to Saary(1995) for a discussion of these problems.

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Electronic Government - Anticipating the Tide of Change

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Electronic government will differ from traditional government mainly in closer cooperation and coordination in "people networks", suggested by the new "physical networks".

1. Introduction

My first anticipation is a technical one: "physical networks". By this I mean electronic networking, spanning all sectors of all societies on a global scale, enabled by: close to 100 percent PC oder Web-TV supply in offices and homes (at first in the industrial states), connection to "information highways", easy to handle GUIs, interoperability via internet technology and via standardization of building blocks such as processors, operating systems, middleware, and application systems, by security levels for information at will, and by ongoing improvements of the price/performance ratio for computer systems ("Moore's Law").

My second anticipation is based on the first one: "people networks". By this I mean personal and institutional networking which utilizes "physical networks". People networks will cause electronic government to be different from traditional government in a number of ways. They are the main subject of this paper.

2. Digital Nerves of Government

a) Electronic government can be described by characterizing three of its ingredients:

- people, inside and outside the public sector, with access to electronic networks
- digital data representing voice, writing, image, and video ("multimedia")

- digital processes (or procedures, transactions, and the like).

Given these ingredients, "the nerves of government" (a phrase coined by Karl W. Deutsch in his 1963 book on political cybernetics) more and more become digital. Similar to a "computer bus" which connects all computer parts, we can picture a "government bus" able to connect, on principle and with exceptions to be discussed and defined, every single office to all the others and to all the institutions and homes outside the public sector.

b) "Digital nerves of government" multiply the availability of people, data, and processes to others by magnitudes:

- People can be reached by others from anywhere and anytime. Traditional hurdles erected by space, time, and hierarchy erode.

- Data which used to be hidden in masses of paper or which we were not even aware of, can be located and accessed ("information on mouseclick").

- Processes of government and administration more and more become computer-supported (from day-to-day operations to unplanned events like emergency management). If suitable, digital processes can be started from anywhere and anytime, or they can become elements of other processes.

c) This quantum jump in availability is going to change the role and meaning severely, people, data, and processes are having in electronic government. Especially, these three ingredients become much more useful for others, and therefore they become more interesting for others. Their easy availability offers synergies through cooperation, however also coordination may become necessary.

- If it is easy to get in contact with people, it becomes more likely that we try to involve others in order to utilize their expertise or to inform them about things that might be of interest to them (only compare the trouble of getting someone at the phone to the ease of email communication).

- If it is easy to access data, it becomes more likely that we look them up, update them, analyze them, or re-use them. E.g., being aware that there might be data out there which could be useful for us, we make more efforts to locate and download them instead of collecting or producing them anew (a facet of the "make or buy" problem).

- If it es easy to access processes, it becomes more likely that we try to integrate them into our own programs and procedures (again the "make or buy" question), or to match our programs with them.

Therefore, part of the good news coming along with electronic government is that we can expect, under certain conditions to be discussed,

- more direct communication between people
- more harmonization and better utilization of data
- more harmonization and better utilization of processes and procedures.

And it should be noted that there is a big difference to former efforts of this kind: It is not central coercion trying to make this happen but the mutual self-interest of the people involved. Rather than central commands to "raise the treasure" of expertise, data, and processes hidden in the public sector, their own self-interest will induce people and institutions to look for better cooperation and coordination because of the new tools and benefits provided to them by electronic networking.

3. Heterarchy, Data Ubiquity, and a Breakdown of Boundaries

a) In view of the foregoing, we can expect more horizontal communication as compared to today's vertical communication, typical for the public sector. Hierarchy is going to be complemented by "heterarchy"; we will see more people solving problems by direct communication ("flat hierarchies", "autonomous groups", self-organization"). Vertical cooperation within vocational "roped parties" or program-specific "fraternities" is going to be complemented by cross-boundary communication; we will see more "open communication" (assisted by "groupware") between the people involved as compared to written communication through official channels only (joint acting implies joint knowledge).

Of course, these "heterarchical" networks of people need moderation in order to avoid disintegration and in order to bridge "cultural" gaps which have developed between the various vertical hierarchies.

Moreover, one must be aware of the fact that the concepts of electronic government (a "seamless world", "government bus", "digital nerves of government") are going to be confronted with an administrative culture characterized by the separation of powers and by other built-in "cracks", established exactly to limit the flow of information and, thus, to weaken the control of government over the people. Here, a new equilibrium must be found.

b1) We can expect more data sharing as well as faster diffusion of news and therefore a higher degree of accuracy, actuality, and reliability of data. This, in turn, will make data more useful ("informative") for more people. And with information costs tending towards zero, the cost/benefit ratios of most information systems can be calculated anew (take just-in-time training in remote locations as an example).

Of course, this requires efforts to establish data inventories ("yellow pages") which also contain "meta data" giving outsiders the possibility to judge the quality of data. Efforts for data matching cross jurisdictions of programs or institutions become urgent in order to make data compatible (e.g. what is the criterion applied in statistics of infant mortality: a life-span of one hour, of one day?).

Given the new availability and freedom of data we can expect new types of institutions acting as "custodians of data" (e.g. agencies accountable for the validity of certain data types like citizen, vehicle, zoning data etc.) or as "arbitrators" (for the evaluation or certification of data, e.g. digital signatures) or as "disseminators of data" (public agencies, libraries, or other intermediaries).

However, important prerequisits for all this to happen are that we obtain a general view of data which are important but can be hidden somewhere in PCs or LANs, and that we make sure that electronic government continues "to leave its footprints behind" as "paper government" used to do; this includes efforts for the preservation of digital records. Also, electronic government must remain verifiable by external institutions like courts or audit offices.

b2) Given the availability of more accurate, more timely, and more useful data and analysis on one hand and a demand by politicians and administrators for information along the lines of New Public

Management (or other forms of public sector modernization) on the other, we also can expect a content shift in the data systems used by electronic government. Better knowledge about goals and effects of public action and about their distribution in society is becoming more important. How can we detect indicators that public activities are necessary? Which programs are indispensible, which are "nice to have"? Which arguments are available to justify and explain posteriorities to interest groups? How can we avoid that a program is inconsistent with others? How can we track service utilization?

Data of this kind are going to characterize the information systems for every sector of public policy, and they are needed for both: hierarchical context control and heterarchical self-organization.

Consequently, our efforts for and our qualifications in information resource management (IRM) need to grow accordingly.

c) We can expect a breakdown of boundaries within the public sector (boundaries between agencies, programs, jurisdictions, or levels of government), resulting in more cross-boundary collaboration. Administrative processes, very often ending at the building walls of the agencies in charge, are going to be integrated, with a tendency to include entire business networks from start to completion. In electronic government, easy availability of processes will suggest or even urge the partners concerned to cooperate directly along "value chains" and to match their procedures. Thus, we likely will get over the traditional "stovepipe syndrom" indicating a preference for vertical communication hitherto.

We can expect more streamlining of processes, alleviation of duplication and inconsistencies, as well as better coordination of programs run by different agencies (e.g. it does not make sense to provide food stamps to persons sent to jail).

Digital value chains also will provide public servants more autonomy to decide where, when, and how much they want to work (telework, telecommuting, alternative offices, part-time work etc.).

Last but not least, better opportunities to integrate workflows will cause more "customer orientation". To look to one's right and to one's left may discover synergy benefits for oneself. This will bring about a higher concern for the output one is producing for one's clients.

One facet of this will be enhanced public access to government information and services. This includes a greater variety of entry points (e.g. front offices, located in the neighborhood of the clients and organized as one-stop agencies), teleadministration via kiosks or PCs at home and in the offices, self-service enabled by smart cards and the like) and higher service quality (e.g. service integration via simultaneous eligibility determination based on life situations like reaching a certain age or status, disabilities, marriage, start-up of a business, and so on, and crossing the boundaries of federal, state, and local administrations).

As public expectations regarding information access and service delivery raise, the removal of physical impediments by electronic government comes in handy. Of course, we must not forget to weigh out better service and personal privacy with care.

4. Electronic Government as Virtual Government

Based on more heterarchy and on better access to data and processes, we can expect electronic government to be a "virtual government" in the following sense: With many physical obstacles removed by digitalization and electronic networking, the public sector will want to "strengthen its strong sides" and to "weaken its weak sides" in order to become "virtuous". Some aspects will be:

- faster innovation brought about by people directly engaged in public activities through both: business process redesign (BPR) and continuous process improvements (kaizen)

- higher concern for and better inclusion of citizens (with "citizen" understood as a metaphor for all sorts of clients of government such as private persons, businesses, communities, other public agencies, NGOs, NPOs, etc.) by citizen information (more transparency of the public sector; "freedom of information" will have a new meaning in electronic government) and by more citizen consultation and participation

- a greater variety of ways to conduct public affairs in addition to laws and hierarchical regulations, among others: moderation of networks of private and public institutions engaged in mastering a problem area cooperatively; concentration on core activities of government; utilization of market economy concepts like consumer choice, pricing, or competition (tendering, outsourcing, benchmarking etc.); or management of "fractal organizations" by delegating authority to fractals as units with self-control and by using contracts as informational interfaces between fractals

- and other aspects talked about more often like: better service, more evaluation based on feed-back information, faster transactions, higher productivity of the public sector, and cost reductions through substitution of paperwork, re-usability of data and procedures, less benefits fraud, and "lean administration" in general.

5. Outlook

In order to support the probable developments described, some promotion by state and administration seems to be appropriate.

A national information infrastructure must be built up which provides access to electronic networking on a broad scale and avoids gaps between "information rich" and "information poor". The qualifications to develop and use the systems of electronic government must be secured; this is very important because electronic government is enabled by technology but has to be shaped by people. The juridical requirements must be met, e.g. for privacy and consumer protection or for the handling and keeping of digital records. The benefits of improved ways of electronic government can be and should be demonstrated by pilot projects and in showcases of best practice.

Finally, politicians and government leaders personally must get involved in establishing electronic governments because much more is at stake here than just technical matters. But their involvement implies that their competences include the ability to control system development, information resource management, information technology management, project and risk management and other related fields. This knowledge is not always available on the higher echelons of government yet, however.

This provided, my anticipation is that the concepts of electronic government will be more than an interimistic "high tide", withdrawing with the next "low tide"; rather, they will have a lasting impact on our understanding of "government".

Some statements on government in an Information Society.

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ICTs are the core technology of Public Administration. ICTs therefore have a fundamental impact on the practices and beliefs of Public Administration. In the following more or less interdependent statements a proto-theory is phrased about Public Administration in the information society to be.

Statement 1

The state is losing its territorial basis. The symptoms of this can, until now, be established in the financial-economic, in the commercial, the fiscal and the penal sphere. ICT developments, such as Internet, facilitate this deterritorialisation and lead to a certain degree of "virtualisation" of the state. The state exists only insofar it succeeds in maintaining and controlling a physical or technological link with (individuals and groups in) society.

Statement 2

The system of "checks and balances" between the powers of the state (Executive, Legislative & Judiciary), between the layers of government and within the authorities of public administration, which traditionally has served as a guaranty of civil liberties and as protection against an over-powering state, is eroding.

Statement 3

The scales of the delicate balance between the public sphere and the private sphere are tilting in the direction of the public sphere. Surveillance technologies deployed by public administrations are seductive, as they promise safety in public spaces, while they at the same time reduce the private space.

Statement 4

The framework of territorial and functional jurisdictions of public administration is gradually being replaced by systems of ad hoc co-operations and coalitions between parts of public administration and public-private partnerships.

Statement 5

Workflow Management Systems are eroding the checks and balances which were traditionally built into public administration by Weberian types of division of labour and other Weberian structural precepts.

Statement 6
As far as information (or knowledge based) systems are taking over the professional epistemic niche and discretionary power of the street level bureaucrat, public administration needs a new professional and ethical foundation.

Statement 7
A new foundation of trust between public administration and society has to be found, to replace the eroded checks and balances between the horizontal and vertical powers of the state, between departments and functionaries within authorities of public administration and between the public and private sphere.

Statement 8
The foundations of democracy tend to be weakened and not strengthened by ICT applications in public administration. These applications tend to reinforce the existing dominant positions of the authorities, party-elites and bureaucrats.

Statement 9
The Weberian bureaucratic structure through which a guaranty of instrumental subservience of the organizations of public administration to their political masters is tried for and assured, is in many parts of public administration being replaced by an ICT structure through which the decision premises of the bureaucrats are determined.

Statement 10
The drastically increased capacities to collect, store, aggregate, analyze and present data for instance in the form of key-figures, monitoring information, electronic models and geographic information systems enable a systematization and rationalization of policy making processes. Such a use of ICTs is, in some domains of policy making, contributing to a less incremental character of these processes.

Source: I.Th.M. Snellen and W.B.H.J. van de Donk (Editors), "Public Administration in an information age: A Handbook", IOS Press 1998, 579 p. (ISBN 90 5199 395 1).

ad 6b) Programm dér Jugendbewegung:

Das Gipfel-Programm:

28. August: Ankunft dér Studenten, abends: erstes Treffen aller Delegierten
Kennenlemen, gemeinsame Abendgestaltung, Aufteilung in die Quartiere

29. August: Team Building Aktivitäten
Intensive Kennenlemphase, Gruppenaktivitäten, Findung dér Arbeitsgruppen, Stadtbesichtigung

30. August: Teilnahme an verschiedenen Seminaren und erste Ausschuß-Treffen
Erarbeiten dér verschiedenen Perspektiven dureh die einzelnen Gruppenmitglieder, Präsentation. abend: gemeinsame Abendgestaltung

31. August: Opening session, Teilnahme an verschiedenen Vorträgen mit dem Ziel die verschiedenen Betrachtungsweisen und Gedanken dér einzelnen Jugendlichen ein fließen zu lassen, Präsentationen während dér Poster session,
abends: Empfang beim Bürgermeister von Wien

1. September: Ausschußarbeit, Teilnahme an verschiedenen Vorträgen, Präsentationen während dér Postersession (Ablauf entsprechend)

2. September: Transfer von Wien nach Budapest mit Zug und Schiff
Kontakté zu anderen Mitreisenden, Meinungsaustausch, Diskussionen

3. September: Opening session, Ausschußarbeit, Teilnahme an verschiedenen Vorträgen, Präsentationen während dér Postersession (Ablauf entsprechend), Ungarischer Abend

4. September: Ausschußarbeit, Teilnahme an verschiedenen Vorträgen, Zusammenfassung der Ergebnisse in der Closingsession sowie Präsentation vor dem Auditorium,
abends: Euro-Party

5. September: Workshops und Seminare

6.September: Abreise der Delegierten

SERVICE IN CONTROL

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Abstract

The contribution is directed to the Panel "Electronic Government - Anticipating the Tide of Change" and the tide of change is up already:

- New information infrastructures and applications are changing the government picture.
- The whole range of ICT-developments is pushing forward.
- At the same time dilemmas are becoming evident.
- Internet infrastructures are overwhelming, but the added value for personal productivity, for direct democracy, for policy making is highly questionable.

ICT has become a major enabling technology to change the current governance paradigm into a service one: Take services to citizens at the government-citizen contact point as basis for increasing individual as well as public productivity for community development, for re-aligning public front-offices and subsequently back-offices.

Service engineering is the driver and challenge for digital government. It does require appropriate research programs, to develop and articulate new evidence, theories and insights.

Special Applications

CyPhone ▪Future Personal Telecooperation Device

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Abstract

Emerging wireless mobile broadband communications systems, such as wireless local area networks, and 3rd generation digital mobile networks create new opportunities for personal mobile telecooperation services and devices for both private and corporate use. Beyond multimedia, Internet and WWW, telepresence and virtual reality hold promise to meet our needs for telecooperation, but the metaphors and ways to reach this are still largely unchartered. Our research addresses a particular domain in this field, mobile telepresence and augmented reality based services and devices. We propose a novel device concept, CyPhone, and illustrate some user scenarios and potential services.

1 Introduction

Recent visionary research [1] strongly suggests future information society going towards virtualisation. Examples of proposed virtual telepresence based services are: virtual meetings, electronic shopping, games and entertainment, guiding and tourist services, virtual village, virtual family, personal memory support systems.

Our work is based on the emerging understanding that there is a major trend towards personal advanced telecommunication services. "Personal" means that these services are *mobile* and conveniently *available* whenever and wherever we want/need to participate in communication activities. We are carrying out a long-term scientific study for *how are we going to bring future* *increasing communication bandwidth and computing performance to the personal vicinity and personal use of individual human beings, meaning everyone of us.* We focus on scientific study of user-interaction layer of the future broadband personal telecommunication products and of services. Through better understanding of user interaction issues of future telecommunication services we believe that, besides scientific contributions, we increase the potential for the telecommunication product and service industry to grow in the future.

Scientifically we are utilising two major approaches to extend the use of computing and communication resources: "*ubiquitous computing*" and "*augmented reality*". "Ubiquitous computing" is a term coined by Weiser [2] to mean a situation, where small computational devices are embedded into our everyday environment in a way that allows them to be operated seamlessly and transparently. These devices are suggested to be active and aware of their surroundings so that they can react and emit information when needed. One implementation of ubiquitous computing are active badges, that can trigger automatic doors and give information about the location of a person. Weiser's team and others at Xerox have experimented the idea by using several types of devices, like small pager-sized "Tabs", notebook-sized "Pads" and whiteboard-sized "Boards" [3].

"Augmented reality" [4, 5, 6, 7] is a research approach that attempts to integrate some form of computer media with the real world. When in ubiquitous computing there are many different active devices, in many cases each of them having their own display and interaction devices, the augmented reality approach usually uses much fever devices and aims at a seamless integration between real and digital. The integration may be between paper and electronic documents, like in DigiDesk [4], or even more commonly overlaying digital information (as a non-immersive virtual reality) on real world images [5]. The overlaying of images may take place in several ways, like by using video projection [4, 8], by the means of small, hand-held video screens or palmtop computers [6], or by mixing surrounding reality with non-immersive VR by using head-mounted see-through displays [4].

The core idea of our approach is that by using a very short distance radio communication network it is possible to mix these two approaches. Thus we suggest "ubiquitous computing" in the form where different devices in spaces and places we move around are computationally active and can recognize our presence and identity. But instead of a multitude of different displays and interaction devices we suggest that the interaction with all devices would take place in an "augmented reality", for example by using a head-mounted see-through display and a mobile phone/remote controller.

2 Augmented Reality User Interface Techniques

- We are especially interested in the characteristics and components of wearable/personal virtual reality systems with following characteristics
- Augmented reality display systems
- Tracking systems
- Wireless communications
- Wearable computing.

Augmented reality display systems

Essential requirements are [9, 10]

- stereoscopic see-through head-mounted display. It is foreseen that augmented reality display will be integrated in eyeglasses, and they have potential to be very cheap because of large sales volumes
- haptic displays; providing touch and force feedback for artificial surfaces and things.

Tracking systems

Tracking systems are needed for many different purposes such as

- head movement; needed for synchronizing and overlaying virtual world with real world
- eye viewing direction; needed for context sensitive viewing and entering commands
- hand and finger position tracking; for gesture recognition and entering commands
- I/O device tracking; for data and command entry
- object tracking; for synchronizing real and virtual worlds.

Wireless communications

An essential requirement for personal augmented reality is that they should work wireless, otherwise the human user is tied with cables and realistic immersion, and the freedom of person movement is lost. Wireless communication is needed between

- components of the augmented reality system, i.e. display, trackers and computing units
- personal augmented reality system and networks services, such as world models and other users/avatars.

Wearable computing

Wearable computing means that the computing equipment is distributed in the near vicinity of the body of the user in clothes or attached somehow to the body by straps or glue, etc. Communication between the equipment parts can be carried out for example by

- wiring integrated in clothes
- using body surface or body water as a carrier of information
- using picocellular personal surrounding radio network.

3 Mobile Virtual Reality Architecture

Several networked virtual reality environments [11, 12, 13, 14] exist today, but none of them supports mobility of users. Most of the networked environments are based on Internet, which could be easily replaced by a mobile multimedia wireless network like SWAN [15] providing mobile connections. However, typical currently available applications and their interfaces, based on immersive virtual reality and heavy desk-top computers, would still restrict the user's ability to move and access services in a natural and convenient way. In the Nara Institute of Science and Technology in Japan [16] an experimental mobile virtual reality system is being developed. This system like ours [17] is based on augmented reality merging both real and virtual environments to provide totally new services and interfaces to mobile observers.

4.1 Picocellular personal surrounding network

The backbone of the mobile virtual reality is a wireless picocellular personal surrounding network (PSN). The PSN network connects user's personal mobile terminals like a head-mounted-display or a pen-shaped input device and provides mobile access to other mobile and fixed networks.

The benefits of using very small cells in mobile virtual reality are obvious. The smaller the cell size, the higher the throughput, because there are fewer users in each cell and higher transmission frequencies can be used. Usually very high frequencies are not used in mobile networks, because of a quick signal attenuation, but if the transmission range is just a few meters, the effect of attenuation is almost negligible. In addition, smaller cell size enables greater frequency reuse. The diameter of a PSN cell in our system is going to be some three meters, which enables the construction of small very low-powered hand held terminals still capable of transmitting high bandwidth multimedia data required by virtual reality applications.

Conventional mobile networks consisting of very small cells have two serious drawbacks: The number of base stations and handovers will be enormous. In our system adjacent PSNs can change information directly without using a fixed base station. This does not only enable wireless communication between user's personal terminals but makes it possible for two users to transmit data to each other directly too. In fact each user's personal surrounding network constitutes a mobile base station, which can forward traffic packets between a fixed base station and some user outside the cell around the base station. In this way the number of expensive base stations needed can be greatly reduced.

The number of handovers cannot be reduced, unless users' ability to move is restricted. But handovers can be made more transparent to the user by e.g. multicasting same data packets to adjacent cells [18]. When a handover occurs, i.e., the user changes a cell, new data packets are already in the new cell and the user does not have to wait the time it takes to forward the data packets from the old cell to the new one. Another problem related to handovers is the availability of services. When a user changes a cell, does the new cell provide the same services as the previous one. In spite of implementing the same services in each network node including the mobile PSNs, it may be more reasonable to get services on demand using e.g. mobile agents [19]. So in addition to data, knowledge about the services required by the user should be multicast in adjacent cells to provide transparent handovers.

4.2 System Architecture

The main components of the system are a fixed base station providing access to fixed networks and their services, personal mobile terminals including virtual reality devices and a mobile base station providing connections between mobile terminals and a fixed network. User's virtual reality devices contain input and output devices and an advanced position tracking system. As an output device we shall use a see-through high resolution head-mounted-display (HMD), with which we augment the real world electronics and telecommunication products with virtual properties and interfaces. As an input device we are going to use a 3D pen mouse, which provides very natural way of entering data e.g. editing a text file. In order to provide a reasonable augmented reality we should track both the output and input devices very precisely. Several methods for tracking the position exist. From these an electromagnetic method based on spread-spectrum communication providing an accuracy of a few millimeters [20] seems to be most promising for our purposes.

In order to keep personal mobile terminals as simple as possible, they should not have much storage space or computation capacity. Data routed by mobile PSNs may be buffered, if the destination PSN is temporarily unreachable, but has not left its position from the routing chain. A PSN leaving the chain notifies immediately its downlink PSN, if such exists and uplink PSN or a fixed base station, so that they can re-create an other routing chain, in case there are enough PSNs in the area. Data addressed to a PSN, which has left the routing chain is deleted without buffering, because it will be delivered to the right PSN by multicasting it to a new cell or a new routing chain.

To decrease the amount of computation power needed by a PSN most of the heavy processes should be distributed across the fixed network and executed in different network nodes. For example in one server node a haptic rendering process can be executed, another may contain a visual rendering process and the third node may contain a process generating 3D audio data, as depicted in Fig. 2. One of the most important processes is a position tracking manager, which determines the locations and positions of the users' head-mounted-displays and input devices from the data it periodically receives from users' sensors. One PSN can contain several position sensors, because in addition to user's head and input device it may be desirable to locate his hands and legs or the whole body too. In addition to a fixed network node, position information is used by a collision manager, which is again executed in an own network node. Rendering processes use both collision and position information to give a user a real-world-like visual and haptic feedback of virtual objects. Finally there is an object manager responsible of distribution of virtual objects on demand.

4 A Future Product Concept Vision - CyPhone

Our current work is demonstrated by imaginary product concept "*CyPhone*" in *Figures 3 - 6*. Please note that CyPhone does not exist yet, it is just a digital virtual reality design model and vision of the future, and we expect that products based on the ideas of it can be real around 2003 - 2008.

CyPhone can serve as a product platform for many potential value-added services. We have considered services falling in to following categories:

- Telepresence services (remote meetings, distributed reviews, tourism, teleteaching)
- Annotation services (guidance, electronic commerce, conference services)
- Monitoring & maintenance services (real-estate and property maintenance and alarm systems)
- Home services (child and seniour citizen day-care, nursery)
- Entertainment services (group games, athletics, training)
- Personal services (pets, tamagotchis, virtual family, virtual friends)

Figure 1. CyPhone has a 1:1 user interface because a touch-pad and a display screen have same size. The shape of left side is designed for bringing the mini displays near eyes.

Figure 2. A person is transmitting with CyPhone as watching through a binocular. The receiver can be anywhere.

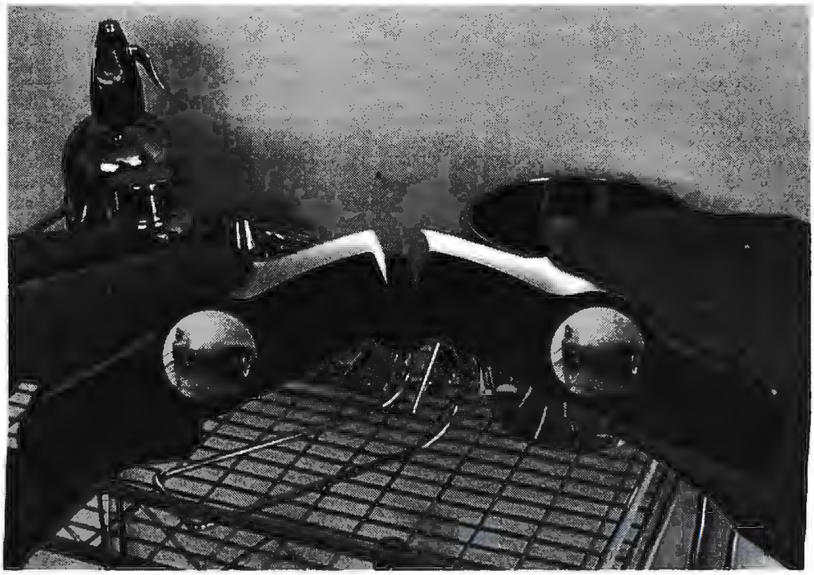

Figure 3. An agent is viewing some objects at an antique shop in London. He would like to hear advice from his customer who is in Paris at the moment.

Figure 4. A customer in Paris is receiving the telepresence call and is able to view the same objects as if being present in London. He can recommend the agent to go ahead with the deal.

Figure 5. Augmented reality sunglasses are an optional CyPhone accessory. They can be used for more convenient viewing visual information.

Figure 6. An example of using augmented reality for guidance and navigation service. A major challenge is synchronization of real and virtual worlds. In this case direction annotations.

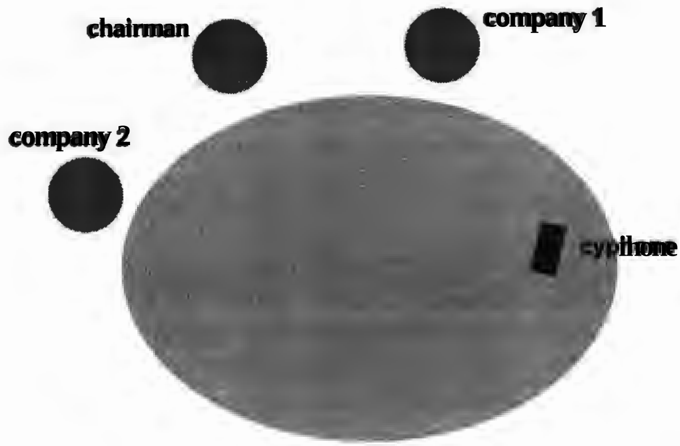

Figure 7. A logical view of a telepresence meeting with a chairman and two company representatives physically present.

Figure 8. Physical representatives of the telepresence meeting.

Figure 9. Chairman's view of the telepresence meeting through augmented reality eyeglasses.

Figure 10. Remote participant's view of the telepresence meeting in a desktop environment.

5 Conclusions

We believe telepresence and augmented reality for natural extension to telecooperation in future personal and corporate environments. Wireless broadband local area networks and public mobile networks can provide a sufficient platform for the transmission aspects. The presentation aspects are much more difficult and need innovation and trials. We describe our approach which is based on stereoscopic personal telepresence terminal, *Cyphone,* and its related user scenarios, part of which are depicted in this paper.

Currently we are building research environment and experimenting with a multimodal personal augmented reality user interface for CyPhone product concept described in this project. For research purposes we are building also partial implementations using today's technology for some parts of the CyPhone concept, for instance, combinations of omnidirectional optical systems and computing algorithms for stereoscopic image capture, compression, reconstruction and display are under research and experimentation. We are enhancing and using our virtual reality prototyping environment [http://www.ele.vtt.fi/projects/vrp/vrp.html] for developing the CyPhone concept further and for demonstrating the capabilities. Hardware prototypes will be built when the level of available technology is mature enough. Additionally some projects are under preparation for elaborating particular user scenarios. One of the first include virtual partly remote meetings, telepresence based multimedia home aid service for seniour citizen, and typical traveling business transactions when arriving a foreign town by flight to go for a sales meeting and accessing technical support from headquarters.

The concepts proposed in this paper are to be tried and verified through research and field trials in *Mobile City Oulu* information society pilot programme in Finland. We are open and looking for cooperation European 5th R&D framework projecs in the areas indicated in this paper.

6 Acknowledgements

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SUPPORTING MAINTENANCE-CREWS IN PLANNING AND EXECUTING COMPLEX TASKS BY ENABLING ACCESS TO EXISTING INFORMATION-SYSTEMS AND ESTABLISHING TELECOOPERATION

Holger Husemann, Christian Kanty, Jörg Petersen, H.-D. Kochs [1])

Abstract

The paper describes a project or an agent based information system respectively that focuses on communication, cooperation and information support for the maintenance area of a complex production plant. In order to establish telecooperation in this area, first an access-system is built, that enables the users to search for information in the existing company information systems. The system employs a user profile in order to retrieve and filter found data according to the individual users needs. Found information can be sorted by the user according to the actual situation, which is determined by the task he is planning or executing and related maintenance-objects. The parameters user, task and maintenance-object set up a context which is used to establish communication and cooperation. By using this context the user will be able to find information about his actual task or the maintenance-object itself, or to look for experts who have dealt already with similar problem situations.

1 Introduction and Related Work

During the last years the number of employees in steelworks has decreased caused by growing production costs, rising competition and therefor initialised rationalisation and automation. Only the number of staff of the maintenance departments remained steadily during the last decade. To initiate a higher level of productivity and cost-effective maintenance measures information has become a key position. In numerous companies information is defined as an important aspect of business-flow. Because of the growing complexity of industrial plants more and more information systems are needed to assist modern manufacturing and maintenance processes.

The system described in this paper arose from the necessity to provide maintenance crews of steelworks industry with information about the actual jobs they are in charge with. The project is

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carried out in cooperation with a steelworks company. About 1100 employees belong to the maintenance area of this steelworks, that employs 3500 people altogether [8]. The main objective is to improve the quality of maintenance jobs by providing as much as possible of the necessary information the individual crew member needs to manage his actual task. Because of the historically grown information systems, their individuality and the plethora of stored information, only a few skilled operators are able to handle a certain system. In order to overcome this situation and to provide general and easy access to the information stored in these systems, an intelligent access system was developed. Soon it became obvious, that this access system can be extended to a knowledge and communication base.

Our work is based on a hypertext system that visualises the object structures and related documents of complex production plants [8],[4]. This system falls back on existing information systems but integrates them by dynamically defined queries. This project focuses on the integration of further information systems and on adaptability. Thus the project touches the field of cooperative information agents [3], information gathering and filtering [9], open hypertext systems [1] and adaptable hypertext systems [6]. Ideas of spatial hypertext systems [5] are used in order to classify the relevance of units of information [2]. The comparison of contexts results from the concept of cases in a case-based fuzzy system [7].

2 Information Infrastructure in a Maintenance Area

The maintenance crew has to react fast to any breakdown of production plants. The necessary information is mostly based on the crew member's experience and on administrative information provided by the disposition.

During the last decades several information systems has been developed to support the maintenance crews. They range from mainframe-based material-management-systems over client-server systems maintaining technical drawings to special local databases that were developed using e.g. Microsoft office products. We state, that most necessary information to solve maintenance-jobs are stored in the already existing information systems. Unfortunately these systems are designed to perform a specific function [10]. Needed information to support a maintenance task has to be queried from several systems and grouped for this special purpose. Each of these systems can be accessed only by a few specially skilled experts. So mostly information will be distributed by managers who "tell"

their crew-members what and how to do. Information systems are only accessed by the job
8 management. This procedure does not take into account that:

- there are maintenance-experts on the shop floor level which could give advice to the actual task,
- there are information systems that hold additional information about the actual task, but these systems are not queried,
- the actual task was probably done before in a similar way but information needed and collected before is no longer accessible.

We try to overcome these problems by providing a system that enables access to several different company wide and local information systems, enabling each user to store the results of his queries according to his actual situation, and looking for colleagues who already have dealt with similar tasks to the one the actual user is in charge with.

3 Supporting Communication and Cooperation

One objective of the project is to initiate and support communication between maintenance experts and beginners on all levels. This is not only done by providing standard telecooperation tools like email or workflow tools but first by supplying the user with an access-system which enables easy and extensive access to all important information systems. This access-system falls back on the existing information systems, queries them and represents the results to the user. These results can be stored in an organisational memory, which is organised in hierarchies according to the maintenance tasks and the technical structures of the steelworks. The third information structure models the maintenance crew members and their organisation in order to enable a mediation service between maintenance experts.

The maintenance crews composed of skilled workers of different faculties (e.g. mechanic, electrician, etc.) are situated all over the steelworks. The idea of the cooperation-part of the system is to answer the questions:

- What information will be necessary to run the actual maintenance job?
- Who provides information about the actual task, the maintenance object?
- Who has already dealt with this specific task, or a similar one (i.e. Who may help?)?
- Are there information-systems supporting the actual job, and how do they work?

The three main-functions (searching for information, structuring the found information and mediation between maintenance crew members), of the system are described in the following subsections.

3.1 Searching for Information

When the user is in charge with a certain maintenance task, he usually can specify the type or name of the task and the maintenance object. This information is the basis for the query. In addition to this the system uses profile data in order to specify the searched information more precisely and to score the results according to the user's profile data (see section 3.2.1).

The result of the query is presented in a list (Figure. 1) where each entry describes what sort of information (i.e. in which information system the entry was found) is referenced and some descriptive details. When the user clicks on an entry, a specialised viewer is launched. The entry itself does not contain the information stored in the referenced system, but it contains a query, that retrieves the needed information. By this the user always receives the newest version and latest updates. This is of importance, because the list entries can be stored and retrieved later on. Two types of queries are distinguished; the search string the user enters and which is attributed as described by the maintenance object and the task is called an *unspecific query*. It is imspecific, because at the time the query is entered, neither the information systems are determined, nor the method of retrieval is known. A specific query is contained in each list entry. It is specific, because now the information system and the method of retrieval (i.e. the key) is known.

As described, the system presents the retrieved and filtered information to the user in a list. The user can browse through these list, view details, and if he regards a list-entry as useful he can store it for later use. Storing and structuring the information has to regard the following aspects:

- There is a strong relationship between the information and the actual situation of the maintenance crew member.
- When information has been stored according to the actual situation, it has to be accessed easily when the same or a similar situation occurs.
- A common knowledge base shall be built up, that will represent the maintenance knowledge of the enterprise.
- In case that another user is faced with a similar task, the system should recognise and present related information stored before.

- The crew members who have handled a maintenance task before and stored information about this, can be regarded as "experts" according to this specific situation. So there has to be a link between stored situations and related crew members. By this the user can find crew members who can provide additional information and advice.

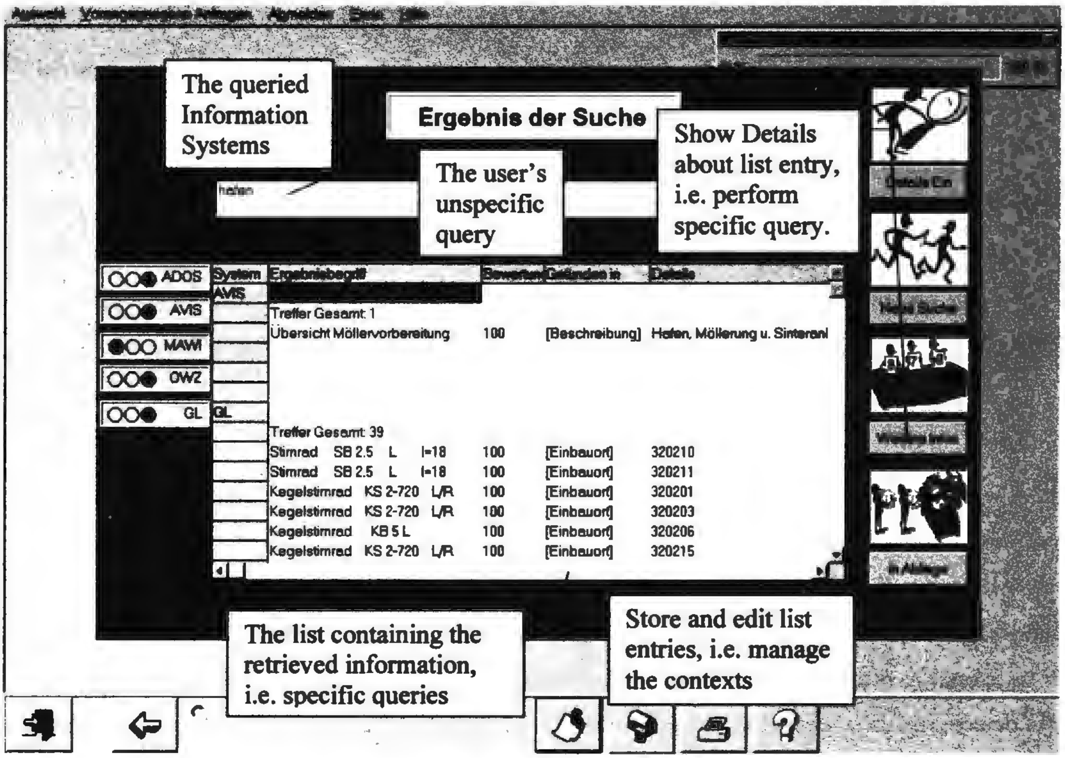

Figure 1: Retrieved Information presented in a list

3.2 Structuring the Information

The actual situation of a maintenance crew member can be described by the attributes *user*, *maintenance object* and *task*.

3.2.1 Structure of the Organisation

The maintenance crews are organised in teams, which are either assigned to a part of the technical plants (i.e. a sub-tree of the structure of the technical plants) or grouped to a central maintenance service. In either way the organisation forms a hierarchy that often reflects the organisation of the enterprise, but it can be modified in order to depict the "technical" aspects of the maintenance crew organisation. Each team consists only of members from a specific faculty.

For each user a set of data is stored and maintained called the *user's profile*. This is done in order to keep track about the individual preferences. The user edits his profile explicitly by choosing the attributes and implicitly by interacting with the system.

3.2.2 Structure of the Technical Plants

Several numeric code systems are in use to structure the technical plants. Each of these codes was introduced in order to deal with a certain view of the plant, and each view is associated with at least one information system, which serves at least one faculty. All of these numeric code systems have in common, that they are organised hierarchically. The nodes of each hierarchy hold information about maintenance objects. A maintenance object may have different names in each hierarchy.

3.2.3 Structure of the Tasks

Whereas the technical plants and the organisation was structured implicitly and explicitly, it was laborious to find a structure capable to hold abstract concepts of tasks. While the organisation of the crews will be explicitly known to its members and each crew uses an implicit or explicit structuring of the technical plant, knowledge about the coherence of tasks is not available. We use a model of the maintenance process, that enables a link between the training of each crew member and the tasks depicted in the model. The tasks are structured hierarchically and additionally a maintenance process is defined.

3.2.4 The Context

The actual situation of a user in charge with a maintenance task can be described using the just defined parameters. These parameters delimit a *context* (Figure 2). This context forms a container that holds the information retrieved and scored by the user. As described before, the user can view the retrieved information, that is presented as a list. The position of an entry in this list reflects its importance to the user. The context can be stored for later use and by this a organisational memory is constructed according to the maintenance tasks and objects.

3.2.5 Communication and Cooperation

When a user has created a context, a relationship between the user and the maintenance object and the task will be made. From now on the user will be explicitly known to the system as someone who may have experience with the specific object and task. Even if he cannot be look upon as a general maintenance expert, the information he has gathered may be helpful to other crew members.

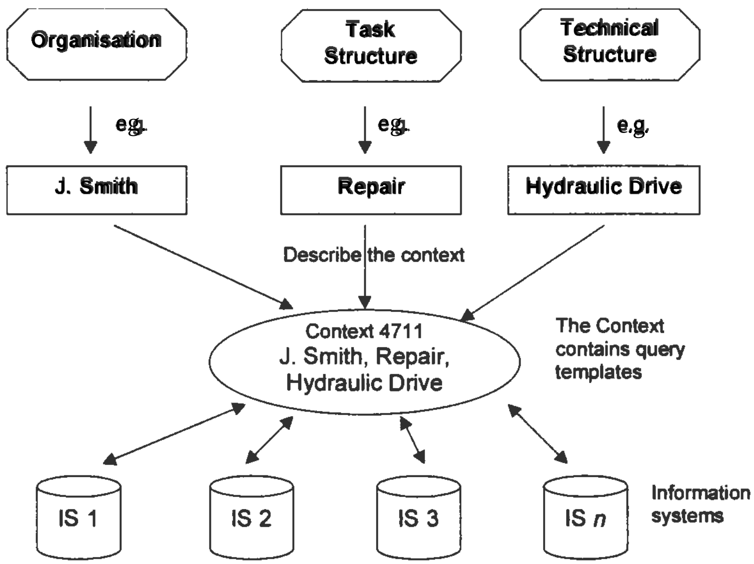

Figure 2: Structure of the Information

Figure 3 depicts how two crew members are linked together. Supposing crew member Miller is looking for information about the repair of a hydraulic drive built-in the continuous casting machine. The system looks for contexts, that describe similar tasks or similar objects. So a link is found, that indicates J. Smith has created a context describing a similar situation and he may help M. Miller in solving his problem.

A graphical interface can present the stored information in form of a disc (Figure 4). In addition to the list as the list, this metaphor is offered as a convenient communication tool [2]. The attributes describing the context are arranged as its compound name at the top. Aroind the circle terms are arranged, which describe aspects of the task. These are predefined in the task structure.

The circle is divided up into two parts. The upper half contains references to information the user regarded as important. These references are presented as icons in order to classify the type of information (technical drawing, report of working condition, notes, etc.). The icons can be moved, copied, or edited. We suggest that the importance of an information should be indicated by the position of the icon; icons close to the centre are more important than icons close to the border of the circle.

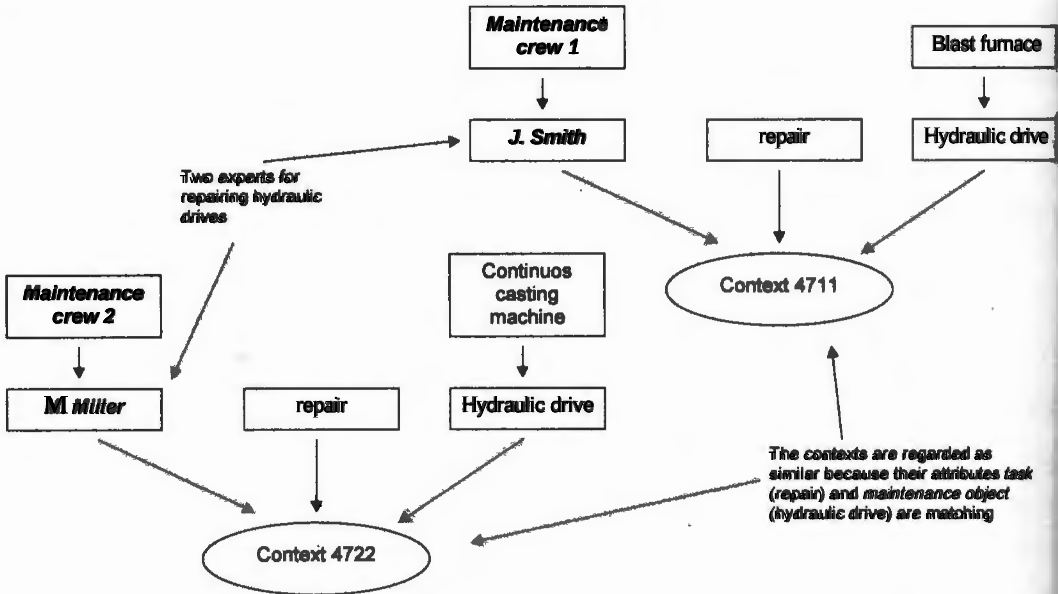

Figure 3: Finding experts by comparing maintenance-objects and tasks

The lower part of the circle presents a context similar to the upper, but owned by a different user. A list of comparable contexts is available the user can browse through. In order to find similar contexts, the user may determine his *term of main interest*. He can choose to look for similar tasks at the same maintenance object or to look for the same task performed on similar maintenance objects.

Information once collected can be accessed by and copied to the actual user's context. The users communicate by offering information. This is done simply by copying icons from the upper to the lower half of the circle. The offered information then can be accepted, edited or deleted by the user.

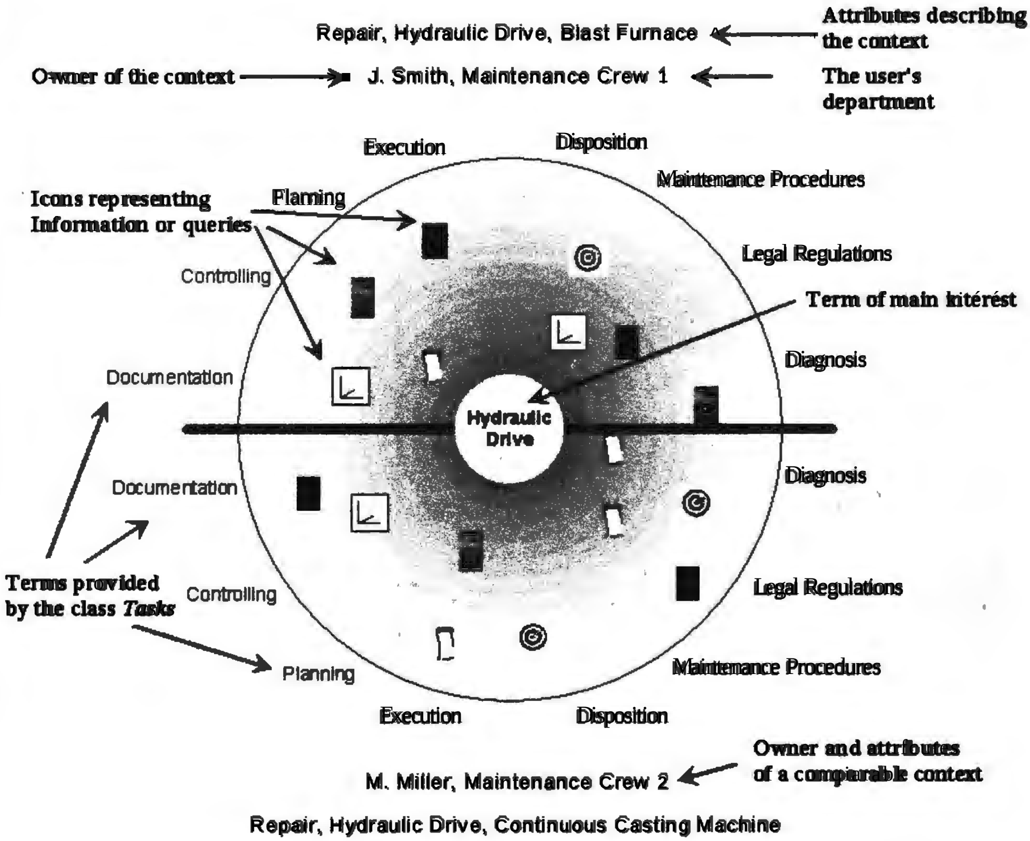

Figure 4: Example for a Context presented in form of the *dice-metaphor*

4 The Architecture of the System

Our system is based on a multi-agent system architecture. The agents are highly specialised modules, which are used to provide the individual user by a personalised information gathering process according to his actual task and situation. Thereby our system supports configurable methods for personalised information gathering, information filtering, structuring of information and cooperation between experts and non-experts. Figure 5 depicts the systems architecture.

First the user specifies his requirements of information with the aid of his personal user interface agent. A self-learning adaptive module, that supports the user with expert knowledge both from specialised agents and from colleagues, who had dealt with the same or a similar task. This agent guides as a personal assistant, who knows the user and its special preferences and interests stored in the profile. The user interface agent can combine the need of information of the user to a set of queries or offer a pre-structured expert knowledge from previous information gathering and structuring processes. In that case queries of a special context are used to fulfil the individual need of information. This need of information will be passed to the facilitator agent, that realises a coordinated agent interoperability for that special purpose, e.g. personalised information intake and structuring.

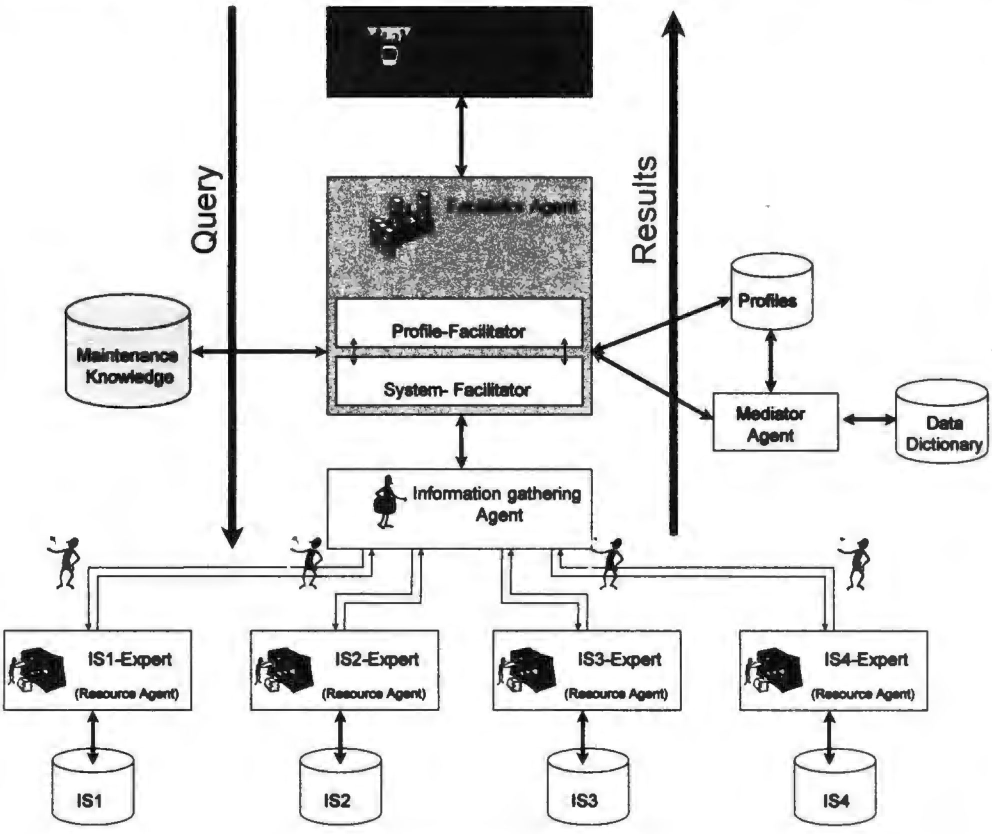

Figure 5: The System Architecture

The facilitator agent instructs information gathering agents to collect information from the different information systems according to the user's requirements described above. To realise this, the facilitator agent disposes of an explicit knowledge of the agents and their capabilities, i.e. their offered methods and services.

The information gathering agents start to consult the connected systems by querying the experts of the individual information systems, the so called resource agents. The Information gathering agents dispose of an explicit communication knowledge about the possibilities to contact and connect the resource agents. In the case of highly distributed systems and resources they contact the resource agents over the best communication mechanism in that individual situation.

Each resource agent disposes of an expert knowledge about his connected system. This agent forms an intelligent top of each system. The results respectively the determined information is gathered by the information gathering agent, that combines and filters the results. Now the information is presented to the user. The user can rate or structure the information and the system learns thereby the user changing preferences which are used for the next queries.

Each agent disposes of several methods, which allow the agent to realise its special task. The essential part is the facilitator agent, which serves as a central information server. This agent coordinates the whole information gathering process as well as the individual agents. According to the architecture described above the facilitator agent combines three fields of special knowledge: the special maintenance knowledge of a steelworks, mediation services, and stored profiles, i.e. user profiles, activity profiles, system profiles etc. These profiles are related to the contexts described above. The mediation services offered by the mediator agent provide a thesaurus and spell checking of the input terms, e.g. for the steelworks three synonyms are used: "S1", "Blasstahlwerk" or "Stahlwerk". A specific search querying the information systems for only one of these terms may supply not all information. The mediation services manages those synonyms..

The resource agents serve as an unique interface to all systems. Each resource agent has individual knowledge of the underlying system. This indicates for example knowledge about the kind and the scope of information. The information gathering agents are used to collect and integrate the special information according to the individual user interests by regarding the special profiles. The agents communicate in a HTML-coded Implementation of KQML (Knowledge Query and Manipulation Language) and KIF (Knowledge Interchange Formalism). As the transport medium for these messages we use various mechanisms like DDE (Dynamic Data Exchange) or email between the different platforms. The advantages of email are both an online and an offline information gathering process in batch mode if the user likes to let collect information "over night" for his next works. By that we provide a flexible system that realises a personalised information gathering as a part of telecooperation.

5 Conclusion and Future Work

We have presented a system that supports communication and cooperation in maintenance crews of a steelworks. The system is based on an access system that operates existing information systems for the user. The results of these queries are presented to the user, who can score them and store the references in a container called *context*. The context is named or attributed by the parameters *user*, *maintenance-object* and *task*. So the context holds information about who was carrying out what task at what part of the production plant (i.e. maintenance-object). The context also holds references to the information the user regarded as useful. By this the context can be used to find information about a task, or a maintenance-object, or it can find experts, who have already dealt with a problem. When an expert is found the user can copy references to information from the expert's context to his own, or he can communicate with the expert. The system is realised by autonomous agents controlled by a facilitator agent. There are specialised agents for each information system and agents to support the individual users.

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SPID-ER: A TELEMATIC CONCEPT TO SUPPORT PROJECT MANAGEMENT

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Abstract

Increasing challenges of international competitions and the global structures of markets need a flexible, dynamic type of organisation with a cost-efficient but powerful information infrastructure. The management of projects in virtual organisations without the possibility of short-timed meetings and with missing definitions of data-flow mechanisms highlights the need for advanced ways of management and therefore the need for new project management tools. Based on an already implemented management platform used in a large European telematic project, a concept to extend this system in the direction of interoperability and flexible data exchange will be introduced, called SPID-ER.

1. Global markets and virtual organisations

In the last few years the pressure of global competition at international markets forces organisations to get in corporations with competitors or to take part in extensive partnerships. The important facts of short-lived product life-cycles, well-informed and self-confident customers and the growing connectivity through world wide information networks make necessary to find new organisational concepts that competitors carry on to be up at the global markets.

A basic requirement for a long termed suceessful existence of a company is a powerful but cost-effieient information infrastructure which has to be available at any time and for any employers. In our information society it is necessary to get information 'just-in-time' to be able to react timely and to adjust the organisations to the new conditions at the markets.

'Virtual organisations' are a possible approach to fulfil the conditions of the increasing challenges. The characteristics of virtual organisations are independence at legal and economical matters, equal rights for all participants, no special employers or physieal head-quarter. The main issue of virtual organisations is a temporary technical network consisting of several people of different departments of different companies.

Each participant brings in his key competence and complementary resources to build a virtual 'best-of-everything' organisation using effects of synergy. The effeet of this should be a win-to-win situation for all partners: advantages in competition due to high flexibility, high productivity and better orientation at customers, higher quality of output because of concentrated competence and efficiency due to flexible structures.

The requirements for building virtual organisations are mutual confidence, equal goals, concurrent moral concepts and intensive communication. Virtual organisations have to be lean, being built up or liquidated in a very short time.

2. New project management needed?

Growing deregulation at markets and general internationalisation cause new tasks and problems for companies and their projects. However there nearly have been no changes at the typical project management and its tools. Although there exist powerful communication and information structures most of existing project management tools and even project managers themselves do not use the possibilities of these networks.

Function	Classic Way	Modern Way
cooperative work	meetings, phone calls, fax, documents	email, video conferencing, CSCW
arrangements	phone calls, fax, memos, contracts	entries into central project database, recording of video conferences
list of working hours	documents, files	entries into central project database
implementation	meetings, phone calls, fax	central directories with versioning tools

Figure 1; comparison of different ways of communications

'Virtual organisations' require modern information infrastructures. Physical distances and possible differences in time zones of organisation members cause the need of an efficient interaction of information technology and telecommunication structure. This system makes possible that transactions can be completed between the cooperative companies to any time at any place in the world. Information infrastructures have to be open systems with distributed data systems and extensive security mechanisms. With the technical network which links individual units comes the virtual organisation into a being. The Internet fulfils most of these requirements: It is flexible, cost-efficient, dynamic and present at the market, its interface is user-friendly and its participation can be joined or cancelled in an easy way. When in 1996 the European Union project TeleRegions SUN with about 70 project partners all around Europe started, the demand for internet supported management tools was given and therefore decided to be one of the project's research goals.

3. Architecture of the TeleRegions SUN management platform

The basic communication system has been implemented in 1996 during the project TeleRegions SUN funded by the European Commission. It consists of several modules. Each partner of the project can access the project related document libraries located on several region specific web servers all around Europe. Some support applications have been implemented and installed as add-ons to one of these web servers to support partners in finding project information: Each document stored on one of the six regional web servers can be registered in a central project database via internet. On the other hand this database can be accessed to find registered documents and partner information data. During the first quarter of the year 1997 a cooperative work tool named BSCW 3.0 (GMD_FIT) has been installed and tested with regard to project benefit. BSCW supports group work over the internet by providing shared workspaces. A workspace allows storage and retrieval of documents and sharing information within a group of persons.

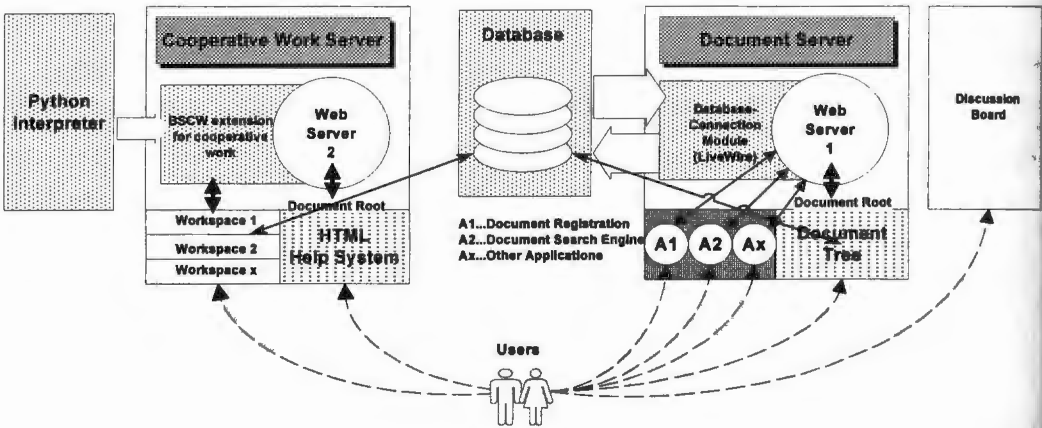

Figure 2: Client-Server concept of the system architecture

4. Extension of the management platform towards modularity and flexibility

The following chapter should provide a future outlook into interregional project management. This kind of work will be characterised by modular systems with the potential of a maximum in interoperability and flexibility. To fulfil these goals some conditions must be complied with simple adaptation into existing systems, possibility of repeated use with different business partners, easy-to-use interface, low level of money investment, reliability and high security level

4.1. General System Architecture

Covering the first condition, which is a core function with regard to business acceptance, the general system architecture must be designed as a client-server system as outlined below:

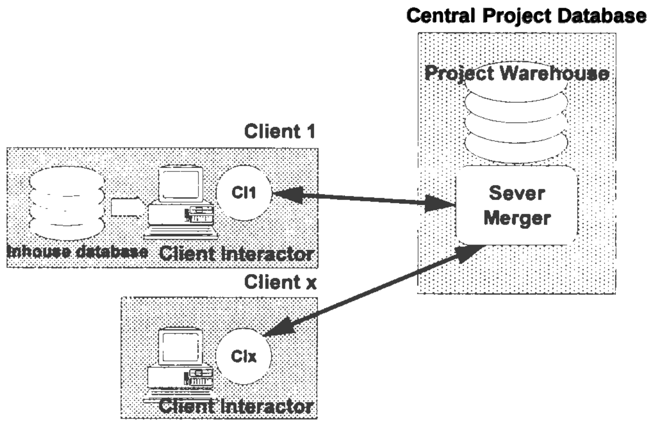

Figure 3: Client-Server concept of the system achitecture

From a software concept's point of view the three core components *client interactor, server merger* and *project warehouse* can be identified. These components can be classified as three separate software modules with the necessity to communicate with each other, what leads to another way of looking at the system – the so-called data view. We have to distinguish between the inhouse data, the "standardised project interchange data (SPID)", which can be equated with a high-level communication protocol, and the warehouse data scheme, which represents the SPID as an extended entity-relationship model (SPID-ER). The following figure integrates the data view into the system architecture:

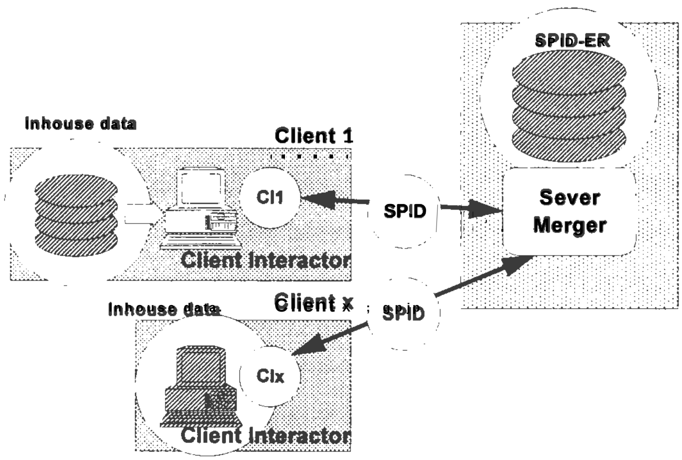

Figure 4: Data View and System Architecture

4.2. Architecture Zoom-In

Client Interactor: The interactor can be seen as a kind of project agent which acts as an interface between the already existing project management software and the interregional project telecommunication-infrastructure, normally named as project extranet. The interactor must have the ability to transform relevant inhouse data into the standardised data format which shall be used within the whole project. This standardised data must be transmitted to the relevant project server, where the server merger has to process the incoming tasks. Because of the goal to design an open high-level model no limitations should be given regarding the concept underlying the communication process between interactor and merger. Both batch-transfer and interactive handshake transfer are possible subject to the possibilities of the partners communicating.

1. *Server Merger:* The merger has just one basic task. It has it wait for standardised data input (as already mentioned the kind of transfer itself must be co-ordinated between the partners) from any authorised client interactor. If input has arrived, the merger must perform a syntax check and, if necessary, react to errors. Correct data will be transmitted to the project warehouse. On the other side, information requests from any interactor must be checked regarding authorisation and if allowed performed immediately to supply the client with project-relevant information.

2. *Project Warehouse (and Project Warehouse Data Scheme):* Basically the project warehouse is the standardised data model (SPID-ER) transferred into a database system. Nothing really unusual except the fact that no changes are allowed concerning the core data model. This model can be seen as a static view of the interactions necessary between the project partners, and because of the need for reusability changes of this model must be given under strict control of some authority. Of course there is the possibility of agreements between two or more partners to extend and use the core model (creation of sub-sets), but these extensions do not belong to the standard and cannot be demanded from new partners without new agreements.

3. *Inhouse Data:* Project information stored in any product-specific format or stand-alone database will be indicated as inhouse data. This data is individual in both the structure and the semantics what leads to incompatibility with other systems. Inhouse data that should be exchanged with project partners is the input for the client interactor, while information transferred from the project warehouse to the client must be transformed into inhouse data.

4. *Standardised Project Interchange Data (SPID):* So-called SPID messages are defined flows of information between individual systems and the central project warehouse, which functions as a clearing centre. Data fields and the meaning of each SPID message are strictly standardised to allow open interaction between all project partners. SPID messages are the only accepted communication form between a client interactor and a server merger. This idea of standardised high-level communication between two modules is comparable with the idea of EDI (Electronic data interchange) and its use in the fields of trade and commerce. To emphasise the familiarity between SPID and EDI, a message structure similar to UN/EDIFACT - which is a very general and common EDI standardisation in Europe - will be used to define SPID messages.

4.3. The SPID-ER Model Realisation Process

The first step in a future SPID-ER model implementation must be a detailed study of project information flow within many different inter-regional projects. The results of this study - information flow models and data models - must be analysed to identify identical flows and data structures and to group similar functions. These data flows must be transformed into the two views of the model:

- *Data View:* Definition of the SPID-ER model, where all the extracted and standardised data will be administered. This model must be realised as database.

- *Data Exchange View:* Definition of a set of messages to exchange the standardised data between the server and the project clients. This set of messages must be realised as a set of rules for message transformation to be used by the client interactor and the server merger.

The following example will explain the difference between these two views: The positive or negative acceptance of a suggested meeting is a permanent communication task that must be done by all project managers. The information (as inhouse data) must be sent to the client interactor (e-mail, web-form, ...). The interactor will change the data format into a SPID message „Confirmation of Meeting" and then send this message to the server merger. The merger will receive the message, analyse the message type and write the information into the database, where the SPID-ER model defines the exact location of the information.

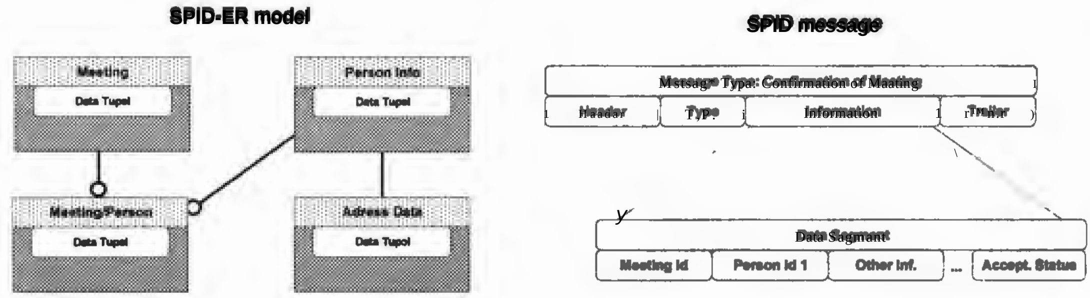

Figure 5; SPID-ER model and related SPID message

A SPID data transfer has the following structure:

- *Transfer header:* This part identifies the message as SPID information including one or more SPID messages.
- *Transfer trailer:* This part closes the whole SPID information transfer (one or more messages)
- *Type:* This part gives information about the type of the message
- *Information fields:* All the fields following a type field carry information in relation to the announced message type. There are two ways to complete this information field section. A new type field finishes the previous message and opens a new one. A transfer trailer closes the whole transfer.

4.4. Extension of the core management platform with the SPID-ER model

The core platform developed and tested within the EU-project TeleRegions SUN, which has been introduced in the previous chapters, can easily be prepared to adapt the SPID-ER approach. The data model underlying the central project database can be seen as a first draft towards the SPID-ER model. Only a view things must be done.

- Adaptation of a future final SPID-ER model

- Addition of the module „Server Merger“ and implementation of the interaction between the database system and the merger.

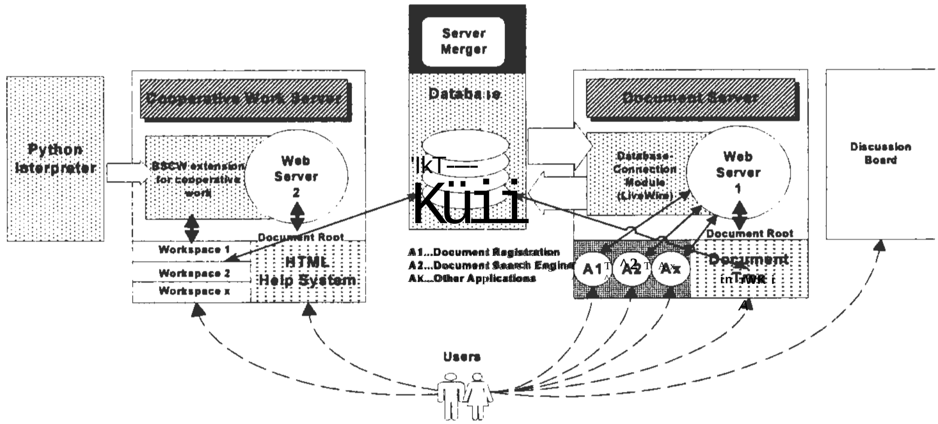

Figure 6: Final system architecture including SPID approach

5. Future aspects – new modules and technologies

Telecommunications technology, information engineering and especially the whole field of internet technology are subject to an enormous change of development and technology. Because of this it is almost impossible to tell what will be done in some years. But it is possible to list some fields of research, where activities are probable.

- *Security:* En/Decoding of data transmitted via interregional networks is already mandatory.

- *Authentification:* The possibility of adding an „electronic signature“ to the transmitted information will help a lot in introducing management systems to business. In this field legal restrictions can possibly affect the concept.

- *Active database/software module functions:* At the moment the system is designed as a passive one. The user triggers actions, the system is mainly a project archive. The design and implementation of active software modules can increase the possibilities to a high amount.

- *Agent theory:* Active Agents will perform many tasks without human interaction. These so-called software robots can be real good assistants handling some everyday life jobs.

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- WG 2.2 Formal Description of Programming Concepts
- WG 2.3 Programming Methodology
- WG 2.4 System Implementation Languages
- WG 2.5 Numerical Software
- WG 2.6 Database
- WG 2.7 User Interface Engineering (WG 13.4)
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- WG 2.9 Software Requirements Engineering

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