Organization on Intranet – An Agent Based Approach

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ABSTRACT

With Intranets as communication channels inhabited by an ensemble of agents, we present a concept to envision, model and implement communication channels for organizations. The approach is based on the media concept and the media reference model. We study how to reconstruct organization, in particular bureaucracy, on an Intranet by employing agents. Moreover, we discuss how the use of a medium can transform existing organizational structures while improving the value and knowledge creation processes within the organization. The approach originated from a project developing concepts for the implementation of an Intranet for a major Swiss bank.

1 INTRODUCTION AND MOTIVATION

Intranets as communication channels of large organizations have various advantages. The technology is standardized and based on open architectures. Various kinds of services for data processing, representation or storage can be integrated. However, communication and coordination services provided by Intranet are of limited use for an organization. They are either general and do impose hardly any organizational structure guiding the value creation process, as e.g., email, or impose strict and inflexible organizational structures and processes, as e.g., typical workflow applications. Generally speaking, an Intranet lacks the means to represent organization and to support (goal-directed) communication in an organization.

We strive to combine the advantages of the communication channel Intranet with the communication structures organizations demand. In particular, we consider the two basic organization models bureaucracy and task force and Takeuchi, 1995)" (Nonaka and Takeuchi, 1995): The advantage of bureaucracy lies in its efficient completion of repetitive tasks while the advantage of task force lies in its support of the combination of knowledge and the creation of new ideas. We reconsider those two organization models to support them by electronic media. Hereby, we apply the media concept 1997)" (Schmid, 1997) (Sect. 2) and the media reference model 1999)" (Schmid, 1999) (Sect. 3). The media concept describes *how to model platforms* for (artificial) agents and the media reference model captures *what agents communicate on those media*. According to those two models, we explore the relation between organization and medium, the potential of the medium Intranet and analyze, how to reconstruct organization on Intranet and how to facilitate a dialogue between organization and medium (Sect. 4).

This work originated from a project developing concepts for an Intranet of a large multi-national bank. The Intranet has been designed to be the communication channel for internal communication and is supposed to facilitate the organizational transition towards a single organizational structure. Departments or sub-units already dispose of their communication services grown over time. Most of them are accessible on Intranet. Heterogeneity and decentralized management are inherent. It is the task of a computer science unit to come up with a concept and an architecture for the Intranet. The requirements are (1) the support of the knowledge and value creation processes within the company (2) the provision of concepts to deal with heterogeneous information services and decentralized management (3) the management of Intranet with the means of the platform and hardly any external policies and strategies. The ideas we present in this paper reflect the concepts for an implementation of a solution meeting those requirements.

2 MODELING A COMMUNICATION PLATFORM

With media we introduce a comprehensive concept to model platforms facilitating interaction. We follow the notion of a medium as developed in sociology. Societies, referred to as media, can be defined as 'systems of places', where every agent has a place with rights and obligations. Media bind agents at a place 1998)" (Schmid, 1998). Thus, the notion of a medium comprises the means to have an organization in which the agents act and communicate and which is subject to reasoning by agents.
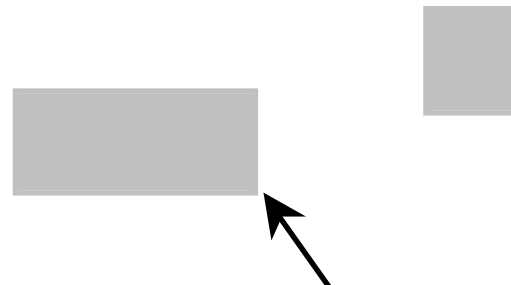
2.1 The Media Concept

The media concept envisions media as sphere for communities of agents (see Fig. 1). According to (Schmid, 1997; Schmid, 1998; Lechner and Schmid, 2000), media are characterized by three main components:
1. A *logical space* with syntax and semantics of the information common to the community of agents. This includes information about the channel system and the organization.
2. A *channel system* for transporting information over space and time and for facilitating communication of information. This corresponds to a medium as a mere carrier of information.
3. An *organization* which describes with *roles* the agents and with *protocols* the interactions among agents.

A medium is utilized by *agents*. The notion of agents subsumes humans, software agents, organizational units, i.e., any entity that plays a role in the game of exchange and communication. Software agents may represent or support humans or companies on a medium in autonomously providing or seeking information, evaluating information and performing transactions and Schmid, 2000)" (Lechner and Schmid, 2000).

Fig. 1 Medium as Sphere for a Community of Agents

2.2 An Analysis of Intranet

In the analysis, we follow the structure of the media concept, discussing (1) the agents residing on the medium, (2) and the medium itself with the three components.

Agents: Each user of the system is represented as an agent interacting, communicating and cooperating with other agents via the common platform. The browser as an agent represents or gives access to Intranet with its documents and specialized information services. Directory services, databases, spiders, robots, search engines, notification services, and programmable agents in groupware systems are other examples for agents. Those agents often lack proactivity, autonomy and deliberation.

The channel system consists of a set of interconnected computers typically including a central web server, the hub, a set of subordinate servers, the spokes, and a set of application servers. The spokes contain the information being of interest to the individual business units, whereas the hub provides general information and the navigational system. Documents are connected via hyperlinks.

Organization: The organization is basically determined by user accounts (the roles) restricting the individual's rights to access documents and to invoke applications (the protocols). It is drawn from the underlying operating system. The applications, as, e.g. workflow systems or communication services as email, chat rooms or recommendation services have their own organizations. Other concepts for roles are, e.g. interest profiles. Thus, we observe a variety of organizational models on Intranet, where the role models however are quite simple and "pull" and "on demand" are the predominant protocols. There are hardly any proactive entities.

The logical space accessible to artificial agents is rather limited. Human agents communicate via natural language and the information represented in the typical "natural language" documents on Intranet carries knowledge explicit for humans, but hardly understandable for artificial agents. They have to rely on the metadata (often given in some formal language). Let us exemplify this with the example of a directory service: A directory service imposes a predefined structure on a collection of documents. While artificial agents do not "understand" the nature of the similarity of documents in the same directory, they know the fact that those documents are somehow related or similar. We observe that the logical spaces of artificial and human agents differ. The gap becomes even bigger in the logical space concerning organization and communication channels. Intranets lack nearly any explicit descriptions of both of them. This prevents the agents from dealing with organization and from acting autonomously according to the organizational structure.

2.3 Intranet as Medium

So, let us discuss how a model of Intranet should look like according to the media concept.

The agents should all be proactive, deliberate and provide means to process and communicate information. They should provide the single access point to Intranet specific to each user allowing for indirect management rather than direct manipulation of information resources and Schneiderman, 1997; Foner, 1999)" (Maes and Schneiderman, 1997; Foner, 1999). As such, an agent has full control over all the information about the user and may or may not grant access to that profile. Thus, the concept of agents empowers the users in the communication with the platform 1999 ID: 665}" (Schubert, 1999; and Schneiderman, 1997; Foner, 1999)" Maes and Schneiderman, 1997; Foner, 1999). Ideally, agents are equipped with communication languages skills, as, e.g., KQML et al. 1994)" (Finin et al. 1994), in order to be able to interact with other agents.

Organization: The organizational structures on Intranet should support the needs of an organization. The user's roles have to reflect (1) his interests needed to support the knowledge creation process and (2) his position within the bureaucratic structure guiding the value creation processes. The protocols then determine the actual shape of those value and knowledge creation processes.

Logical space: All the above mentioned enhancements are of little use if the logical space, in particular the one explicit for agents, cannot keep up with it. Structured metadata about documents and about the user and his behavior has to be provided. Dedicated management agents may then take over the task to monitor and manage the channel system 1999; Riedl and Takashi, 1999)" (Riedl, 1999; Riedl and Takashi, 1999). Looking at the sheer amount of documents, the dynamics of those systems, and

the evolving requirements towards metadata that data needs to be collected automatically by dedicated agents 1999)" (Ginsburg, 1999). Moreover, by collecting and analyzing metadata, artificial agents can build up their own logical space, at least reflecting and comprising the structure of the document space as well as the behavior and interest profiles of the other (human) agents.

2.4 The Formalization of the Media Concept

A formalization of the media concept is prerequisite for the implementation of the platform and the artificial agents. In this section, we give the structure and the components of an information architecture of media. This architecture is a framework for combining application and component specific modeling languages to a medium (and not a uniform universal description language.)

We employ General Logic and Meseguer, 1997)" (Cerioli and Meseguer, 1997) as the framework to select formalisms and relations between formalisms and *Labelled Deductive System* 1996)" (Gabbay, 1996) to compose components and component specific formalism to form a medium.

We define a medium M to adhere to the structure (Lechner and Schmid 2000):

$$
\begin{array}{llllll}
M = C_R: & L: & Th_R: & M_R: & J_R: & N_R: & \text{Roles} \\
C_P: & L: & Th_P: & M_P: & J_P: & N_P: & \text{Protocols} \\
C_D: & L: & Th_D: & M_D: & J_D: & N_D: & A \\
C_C: & L: & Th_C: & M_C: & J_C: & N_C: & \text{Channels} \\
C_{CS}: & L: & Th_{CS}: & M_{CS}: & J_{CS}: & \text{ChannelSystem} \\
C_{OS}: & L: & Th_{OS}: & M_{OS}: & \text{OrganizationSystem} \\
C_{MS}: & L: & Th_{MS}: & \text{ModelSystem} \\
C_{SS}: & L: & \text{SyntaxSystem} \\
C_{LS}: & \text{LogicSystem}
\end{array}
$$

(MRRole(C_R), MRProtocol(C_P), MRDomain(C_D), MRChannels(C_C), MRChannelSystem(C_{CS}), MROrganizationSystem(C_{OS}), MRModelSystem(C_{MS}), MRSyntaxSystem(C_{SS}), MRLogicSystem(C_{LS}))

Let us briefly explain this structure. The *rows* each correspond to a component of a medium namely (1) roles, (2) protocols, (3) domain specific information, (4) channels, (5) the channel system of a medium for the distribution over space and time based on names and a predicate on names, (6) the organization system modeling how tacit and explicit information for each component are blended and how information in components is interrelated, i.e., how the organization governs agents, (7) ModelSystem for relating the component specific models, (8) TheorySystem for relating the signatures and the theories determining the language and modeling the tacit knowledge of a medium, (9) Logic System for relating the general logic, and (10) (MRRole..) for describing the roles of the various components of a medium.

The *columns* correspond to a particular kind of information. C_X is the component name, Th_X the theory with language and implicit knowledge, M_X captures the models, J_X blends tacit with explicit knowledge, N_X is the address system of a medium and Roles, Protocols, A, Channels the more explicit knowledge of the medium.

3 MODELING AN INTRANET - THE MEDIA REFERENCE MODEL

The media reference model (MRM) captures *what is to be modeled* by an ensemble of communicating agents. In particular, it captures the issues relevant for modeling organizational structures for a collection of communicating agents.

3.1 The Media Reference Model

The MRM (depicted in Fig. 2) distinguishes four phases (and four views which we do not consider here). Subsequently, we give a short description of the phases according to 1999)" (Schmid, 1999). For exhaustive explanations and discussions of this model we refer to 1999; Schmid and Lindemann, 1998)" (Schmid, 1999; Schmid and Lindemann, 1998):

In the *knowledge phase*, the common logical space with syntax and semantics is provided. This common logical space is prerequisite for signaling, negotiation and settlement: In the *intention phase*, supply and demand are signaled by the agents. In the *contracting phase*, the agents communicate their individual intentions (resp. desires) and negotiate a com-

mon intention stated in form of a contract. The contract is -as a protocol- part of the new organizational structure determining, formalizing, and thus externalizing the organization of the settlement phase. In the *settlement phase*, the agents act according to that organization.

Those phases distinguish themselves in their communication acts, i.e., more precisely, in the effect of communication on the organization, i.e., the illocution of a message and Searle, 1970; Stein and Maier, 1995)" (Searle and Searle, 1970; Stein and Maier, 1995). Messages of the knowledge phase are purely assertional, messages of the intention phase are not binding, i.e., they have no effect on the organization. A message of the contracting phase is legally binding. E.g., an offer is an obligation to act as indicated in the offer when it is accepted, i.e., it changes the organization with roles and protocols of a medium. Messages of the settlement phase change the organization in settling contracts.

3.2 Application of the MRM to Intranet

Let us study the medium "Intranet" according to the MRM. We make two observations:

- The medium supports the dissemination and the exchange of information about the organization, about transactions, about the agents being part of the organization and about some domains. Thus, messages are mostly assertional. Information concerning transactions is exchanged however transactions are not performed on the medium. Thus, an Intranet merely supports the knowledge phase.
- The medium hardly reflects any organizational structure. The organization as represented within the underlying operating system is static, with predefined rights to access and modify documents or applications. Information about channels and organizational structures existing within the company can be communicated but are not mapped onto the medium and thus cannot be controlled or enforced. There do hardly exist any efficient communication and coordination mechanisms.

To support, control and enforce organizational structures, and facilitate artificial agents to act autonomously on a medium, the organizational structures have to be reflected by the medium.

3.3 Medium to Implement Organization

We suggest to employ the concept of contracts to specify hierarchical structures, being characteristic for bureaucratic organizational forms et al. 1999)" (Schopp et al. 1999). A contract is a protocol, that determines the behavior of the agents being bound to that contract. The implementation of contract-based organizational structures depends on the following conditions to hold:

- Agents have to have messages to signal intentions and to negotiate, sign, and settle contracts.
- Agents need a common logical space, to coordinate offers and demands and to formulate contract conditions (see, e.g., and Prusak, 1997)" (Davenport and Prusak, 1997))
- Agents need coordination mechanisms, as e.g., auctions, and locations where they can meet and which offer coordination and negotiation services.

The advantages of contracts lie in:

- A reduction of coordination and transaction costs of complex or repetitive transactions (as e.g., of subscription services or simple standardized business processes).
- Stable relationships as a prerequisite for planning.
- Flexibility due to individually negotiable contracts.
- Means to record and/or enforce the process of settlement.

3.4 Formalization of the MRM

We give a very brief outline of how to model media according to the media reference model with a special focus on the relation channel system - organization.

Media distinguish themselves in domain specific knowledge and their set of communication messages. The domain specific information has to be embedded into the messages. An implementation relation between the phase specific sets of communication messages has to be given, saying, e.g., that an offer to send information X implements an intention to supply information and that sending X via e-mail implements an obligation to supply X.

Those messages have to be transported on the channel systems. Accordingly, the interrelation of channel system and communication mes-

sages has to be defined for all four sets of messages together with their refinement relations.

Then, the messages have to be embedded in the organization, i.e., for a message m, Obl(m) and Per(m) model as part of roles the right resp. obligation to perform m (when employing deontic logic (Maibaum, 1993)) and [m]p and <m>p (box m and diamond m) model in protocols that m can happen such that p holds and that always after m p holds (when employing temporal logic). Again, messages and implementation relation have to be embedded in the role and protocols descriptions. This embedding may involve some abstraction.

Thus, according to the MRM, there are sixteen logical spaces indicating that each phase and each layer has its language and semantics together with the mappings of transactions into the view specific languages as well as the refinement relations between the phases. This structure of logical spaces with their interrelations are generic for media while transactions and domain as well as the implementation relations are specific to media.

Each phase distinguishes itself by the communication messages, by a „place" on the channel system to meet and to communicate, by protocols to communicate and coordinate and by the roles involved in communication and the actions to be taken to reach a goal (the processes). Protocols, roles, place and transactions characterize the services supporting a phase.
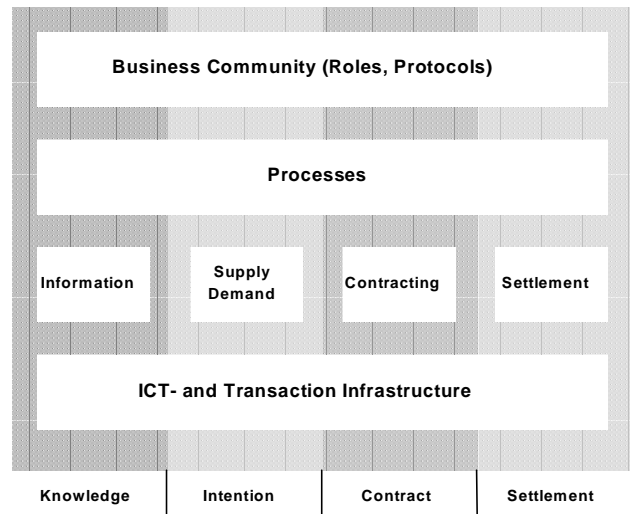
4 RECONSIDERING ORGANIZATION ON INTRANET

In this section, we explore how to implement an organization on an Intranet following the concepts developed in the previous two sections.

First, we state that there is a dialog between the tacit organization employing a medium and the explicit organization represented on the medium. This dialog is similar to the one between explicit and tacit knowledge 1994)" (Nonaka, 1994). It originates from the fact that (1) the explicit organization is a partial representation of the tacit organization and (2) that the platform or technology enables new forms of coordination leading to new organizational structures. We argue that this drives the development of new organization forms converging to a single organization.

Second, the dialogue of organization employing a medium and organization emerging from a medium has to be refined to capture *what* to relate in explicit and tacit organization: An Intranet is a means to communicate information among (artificial) agents. It may support agents with a strong interest in communication and collaboration. Thus, it naturally supports the communication needs of flat organizational forms as task forces. However, an organization typically also has some bureaucratic structures. We suggest contracts as means to establish and externalize such – at least temporarily -fixed communication structures.

Third, the gap between bureaucracy and the efficient and open channel system with interest driven communication has to be bridged: Roles described in permissions and obligations describe the function of an agent in an bureaucratic organization, the profiles its interests and capabilities in

Figure 2: Media Reference Model (MRM)

| Business Community (Roles, Protocols) |
| Processes |
| Information | Supply Demand | Contracting | Settlement |
| ICT- and Transaction Infrastructure |

| Knowledge | Intention | Contract | Settlement |

a task force. Bureaucratic structures are predefined and static while a profile system emerges on the medium. Efficiency is gained from both (1) predefined channels and coordination protocols given in bureaucracies and also from (2) interest specific communication channels, with "push" or "on demand" protocols. Note, that it is the platform that may let the interest profiles and enhancing protocols emerge and that those roles and protocols may be again externalized into contracts – to form again a bureaucratic structure. Thus, at this level there is a dialogue between the two organization principles and their means to establish efficiency in communication.

Forth, it remains to be discussed how a medium is established that facilitates collaboration among artificial and human agents. We cannot expect artificial agents to be smart enough to understand humans and humans not to be so sophisticated to express themselves in formal languages. We suggest a dialogue between humans and agents: Humans represent a lot of information in unstructured documents, which can hardly be understood by artificial agents. To facilitate agents to construct their logical space, human agents should communicate via agents such that those agents can observe human agents and capture the kind of information they can deal with. Despite the fact that agents are not capable of understanding the nature of the interaction, they can record it, analyze it, and relate it to human users. In this dialog of human and artificial agents, agents reconstruct some of the human's explicit and tacit knowledge as their explicit knowledge.

5 CONCLUDING REMARKS

This paper presents a concept to envision and implement communication channel of an organization. Agents provide the organizational structures on an Internet that organizations demand for. We explore the dialog between the open distributed structures on which agents may communicate and the bureaucracies with their graded authority. We demonstrate, how efficiency and effectiveness in communication and coordination - the requirements bureaucracies are designed to meet- can be met on open, distributed channels like an Intranet. In our approach, agents bridge the gap between bureaucratic requirements and potential of technology with its communication channels.

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