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Sharing Knowledge on Knowledge – The eXact Peripheral Expertise Awareness System[1]

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Abstract: This paper presents an innovative approach to solve the problem of missing transparency over competencies within virtual organizations. We based our work on empirical studies on the problem to cope with the problem of competence finding in such distributed organizations. Former studies have shown that central storage of profiles is inappropriate due to missing flexibility and high costs of maintenance. The focus of our approach presented here is to support the peripheral awareness of competence-indicating events. Those events can be collected, stored and interpreted by the system without further work of the users. This idea is based on existing works on the awareness in computer-supported cooperative work scenarios.

Keywords: Groupware, Knowledge Management, Expertise, Awareness
Categories: H.5.3

1 Introduction

Many modern organizations can be seen as network organizations. Their participants are individuals as well as organizations, who cooperate in distributed teams. Especially in knowledge-intensive domains (service engineering, consulting, etc.) project teams are made up of participants from different disciplines and organizations to unite their special competencies and to match project necessities. Problems occur when trying to establish a shared knowledge management for those teams respectively for the participating individuals and organizations.

An important challenge here is to give mutual orientation of the respective competencies to every team member, as it is usually embedded in the cultural practice of collocated work settings. Consequently, when thinking of computer support for those settings, not only shared distributed knowledge databases and appropriate retrieval systems have to be organized but also the missing peripheral awareness which is essential for working within a team has to be compensated electronically.

Our approach concentrates on the demand that competencies within a network or virtual organization [Picot et al. 98] have to become more transparent. Members of

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"traditional" companies get to know each other in a “natural way” through office sharing, business lunches, periodical meetings, etc. Virtual organizations are characterized by

- highly distributed work scenarios,
- mainly computer-based cooperation,
- highly (organizational as well as legal) independent partners, and
- temporally limited cooperation.

So, peripheral awareness on colleague’s competencies becomes a much harder problem. Some reasons that can be derived from the characteristics of virtual organizations and the missing shared work practices and organizational cultures are:

- Lowered motivation to present own competencies (because of temporal cooperation)
- Difficulties in building a joint organizational culture (because of the fragmented work settings)
- Lowered willingness to participate in group’s activities and to do work on the shared infrastructure

The intensive use of computer-based communication and cooperation can be seen in two ways: On the one hand the expressiveness of communication is lowered by media as email (in contrast to personal face-to-face communication), on the other hand, one can try to use the information (and meta-information) which are automatically generated by the use of computer-based cooperation.

So the idea presented in the following is to use the concept of awareness systems [Sandor et al. 97] (known from the groupware context [Johansen 88]), to capture competence-indicating parts of the daily working processes and generate information based on derived hypotheses on the competencies of group members.

In the next section we will give a short overview on existing works which deal with the idea of supporting peripheral awareness within groupware settings. Furthermore we will describe basic concepts in the field of knowledge management, which have an influence on our work, and integrate both areas. After that we will describe our view on virtual organizations and problems regarding their knowledge management concepts in more detail. Here, empirical findings taken from the project OlViO (Organizational Learning in Virtual Organizations, see **www.olvio.de**) are discussed. Finally we present our concept of Peripheral Expertise Awareness and a first prototypical implementation.

2 State of the art

In most virtual organizations collaboration is done via groupware systems. Such systems provide for several communication techniques (email, video-conferencing, shared workspaces, news groups, workflows, etc.). Some of them have integrated awareness facilities [Mark et al. 97]. Awareness services generate information about other users’ working and using behavior. For example one gets to know if a document is replaced, an email is sent, etc.

Research on electronic support of peripheral expertise is done for more than a decade. It is derived from the idea that in work context not only explicitly published information is relevant but also implicitly ones are [Heath and Luff 92]. This idea was integrated in the context of computer-supported cooperative work where events

relevant to the working context are stored and distributed to the users [Dourish and Bellotti 92], [Rodden 96], [Benford and Fahlen 93]. There are two problems with these approaches: First, the privacy of the users is tangled [Schultze and Vandenbosch 98], [Bellotti and Sellen 93]. The second problem is that most of the information generated and distributed by the system is irrelevant to most of the users [Hiltz and Turoff 85], [Schultze and Vandenbosch 98]. Those problems are addressed by configurable awareness systems [Rauschenbach 96]. They have to be addressed individually whenever implementing an awareness system into an organizational context.

The problem of making competencies transparent can be seen as part of the more general problem of broadcasting meta-knowledge which was raised by [Krogh and Venzin 95]. They discussed five main tasks that have to be performed by knowledge management. The technical support of knowledge management within organizations was oriented mainly by the idea of creating an organizational memory [Walsh and Unger 91]. This resulted in the management of huge distributed information bases (i.e. [Akscyn et al. 88]). This approach has some shortcomings. For example [Bannon and Kuuti 96] noted that these solutions isolate knowledge from working processes in which it is needed.

Other approaches concentrated on the support of communication [Ackerman and Malone 90] due to the fact that not all the knowledge can be made explicit [Nonaka and Takeuchi 95]. In this context the idea of virtual information and communication spheres that can be adapted cooperatively was discussed [Shum 97].

Recent approaches take into account that not only information has to be organized but information sources, that are human experts (i.e. [Ackerman and McDonald 96], [Yimam and Kobsa 02]). In many cases this is done automatically. Ontologies are used to characterize and categorize experts. For example, [Groth and Bowers 01] argue that the expertise recommender approach [Ackerman and McDonald 96] uses heuristics which work in one special field of application and are not transferable into others. Instead it might be more useful to use an awareness system that helps understanding a group's working context. User actions then can be interpreted according to the user's competencies. This finally is the main idea of our work.

3 Knowledge on available expertise in virtual organizations

There are mainly two different perspectives on the need to know about the expertise of members of a virtual organization. On the one hand individual needs are defined by persons who have a problem and are searching for an expert which may help. On the other hand there are organizational needs. Every organization or team leader has to know about existing competence. They influence project work, team building, and have to be taken into account when outlining the future perspective of the organization. Especially in knowledge-intensive domains one has to take a careful look at developing expertise over time.

In the OlViO project we investigated the work processes and the knowledge management practice of two consulting companies. 22 members of those organizations were interviewed. We identified several problem cases for a lack of transparency of expertise within the organizations:

- *Individual education*: A person wants to ask an expert on a new field of expertise.
- *Project team building*: A team leader has to find a new person with certain competencies since the "usual experts" are working in other projects.
- *Ad-hoc-acquisition of follow-up projects*: After finishing a project the customer asks for another project with a slightly different focus. Are the necessary competencies available?
- *High probability of "doing the same job twice"*: Best practices can be adapted and used in a new context, if they are mediated by knowledgeable persons.
- *Integration of new members*: Competencies of new network members have to be assessed, and new members have to familiarize with the expertise available (to get help as well as to position themselves).

All these problems show that transparency on the expertise of cooperating partners is needed in many ways. Usually organizations try to address this problem through maintaining profile databases or similar information spaces. In the network organizations we investigated, that these approaches failed because of the decentralized structures and the autonomy of the network members. We based our approach on communication means instead of data storage. It follows two lines of research:

- *Integrating communication channels to experts into knowledge and best practices bases*: Several authors [Ackerman and McDonald 96] deal with the concept to enhance knowledge bases or case-based reasoning systems by communication channels which allow for direct communication with experts. First it shows the need for knowing about expertise, secondly *observable* communication seems to be a very important way to share knowledge [Pipek and Won 02].
- *Using notification services to provide peripheral awareness of expertise*: We explore offering a semi-automated observation of those of the other's activities which might indicate (the gain of) expertise. The goal is not to automatically "protocol" expertise in a database, but to enrich every cooperators work context with up-to-date information for building a mental model of available expertise.

4 Awareness Systems as Knowledge Management Tools – The eXact Idea

As described above peripheral awareness during the working process can be helpful for learning about each others competencies. This is mainly done by interpreting several pieces of information. For example one could say, that people who are called very often and then always talk about Java, J2EE, etc. seem to be experts in the field of object-oriented programming in general and Java in particular. So an awareness system integrated into a virtual organization's groupware could be very helpful for disclosing expertise. After all much of the information (i.e. reading news groups, answering mails with the topic "Java", c.f. figure 1) needed can be generated by the system. Initial events are available in every groupware system. They can be enhanced

by text retrieval techniques to provide for more precise differentiation (i.e. if a user posts a message into a group not only the event "posting a message" can be generated but it also can be analyzed if this posting is a question or an answer). Those events are needed to corroborate a hypothesis like "Java expert" as described above. Our idea is to automate the corroboration of hypotheses.

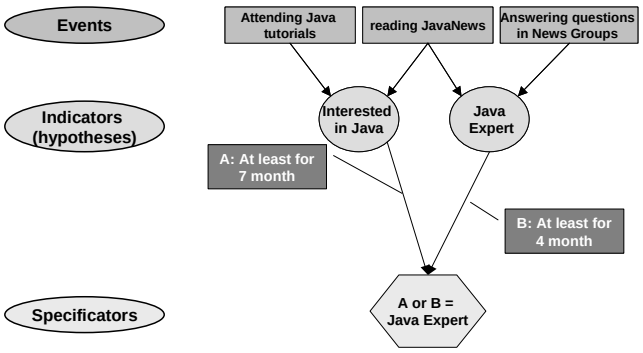

Figure 1: Events, Hypotheses, and Specificators

Furthermore, every user of the system might use the hypotheses from a different perspective. For instance, a programming novice might think of an programming expert as someone who is interested in the Java Programming Language for at least seven months. Programming experts would regard such a person as advanced but not as an expert. So, the design and combination of the specificators have to be done individually due to interests and experiences.

The eXact system can be described as an enhanced awareness system. It is depicted in figure 2. On the left side there are several indicators which use event sources and their events (i.e. "Document X was opened" or "Newsgroup Y was read") as indications. Those indications can be the events themselves or accumulated events like ("User X reads Newsgroup A regularly"). The indicators are connected to hypotheses objects which are used to define which meaning one or the combination of several indications can have (i.e. "User G is an Expert on topic C") . On the other hand users are able to modify incoming indications by self-defined specificators. Those specificators are used to redefine a hypothesis or to combine two or more hypotheses to a new (stronger) one. For instance, there are two hypotheses which indicate that someone is a good programmer and is interested in the Java Programming Language. Both then could be combined to the hypothesis that if both hypotheses are fulfilled that means that someone is a good Java programmer.

These two steps are the heart of the eXact idea. It is then integrated into "traditional" awareness system where hypotheses events are stored and distributed to other users. As we can see our model deals with three filters: The privacy filter is needed to prevent users or user groups from seeing all the hypotheses which are fulfilled. As in traditional awareness systems it is not always wanted that all colleagues can get all the information which belongs to one person. Additionally,

there is an organizational filter which filters indicators according to the organizations' policy. On the other hand a user might not be interested in special topics.

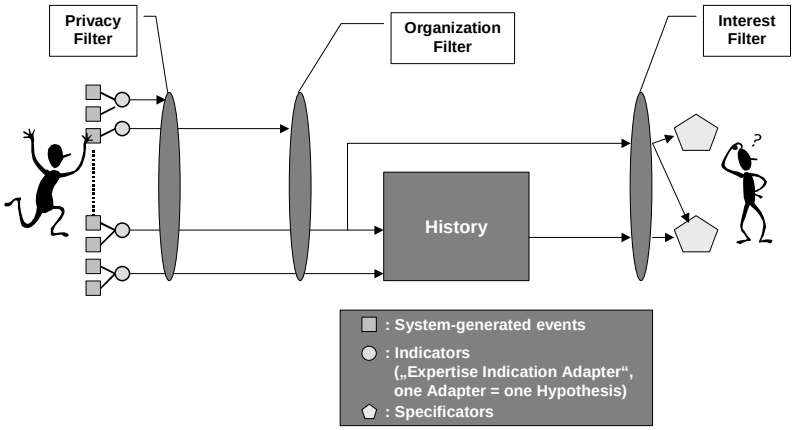

Figure 2: eXact awareness model

Events have to be chosen as well as indicators have to be defined individually for each organization. They should be adaptable as interests as well as working style (and therefore the need for changed indicators) emerge over time.

The Peripheral Expertise (PEA) model was realized in a first prototype. The indicators are connected to a news group system. So all information can be scanned easily as it is text-based. As we can see in Figure 3a the Expertise Awareness Manager (*EAMa*) allows for adding, removing or changing indicators as well as for describing hypotheses graphically. As described above there is a continuous need for re-configuration which should be done by the users themselves. They are the only ones who know their domain and working behavior exactly. So the configuration of the system has to be very easy.

Figure 3b shows the Expertise Awareness Monitor (*EAMo*) which presents the actual expertise levels of several persons according to a special topic. The design is taken from existing awareness models [Mark et al. 97].

Using a news group system as communication medium and as basis for the implementation of our indicators has several advantages:

- *Available information*: All information that is scanned is public. So, in the first run no privacy issues have to be mentioned.
- *Easy scanning and further processing*: Source information are in plain text. So, the indicators can be implemented using well-known text analysis techniques.
- *Public communication on expertise*: Furthermore using news groups in loosely coupled cooperation scenarios can have positive effects as private discussions become public. Thus, peripheral expertise awareness is enhanced simply by public availability of communication within the group.

In a second step we plan to integrate the *EAMo* into the forum system. Then, awareness messages can be publicized automatically. Furthermore, user's expertise can be visualized. This should be done in a personalized way (every user has a different view on the colleagues according to the hypotheses set in the *EAMo).*

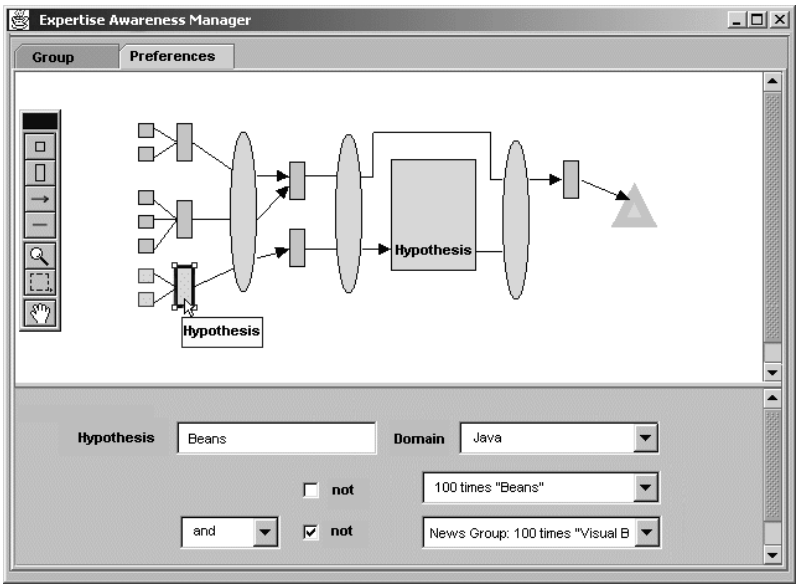

Figure 3a: Expertise Awareness Manager

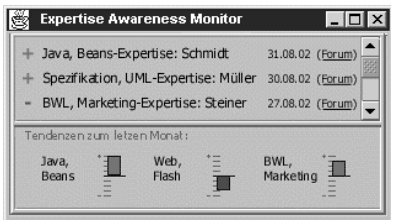

Figure 3b: Expertise Awareness Monitor

5 Validity of Hypotheses

With the Expertise Awareness System members of a group have the possibility to visualize expertise and their sources within an organization. What remains is the problem to decide whether the indicated information is valid. Here only weak technical support can be given. There are two ways to get more valid information.

From one's own perspective the choosing of indicators is the first step not only to filter information that is not needed but also to disable indicators that are based on hypotheses that might be weak. Here, the combination of indicators done in the specificators can help also. Weak hypotheses can be combined and then might be strong enough to indicate competence.

The second possibility is to use those individual validation techniques by evaluating them. Here a heuristic approach is used to find strong hypotheses by analyzing the individual configurations of the group members. For example, if many users think of an indicator as very helpful, this hypothesis is marked as strong. Furthermore, transitive relations can be introduced to weight users and their competencies. If an experienced user marks an hypothesis as strong this is interpreted as a more important piece of information than if a beginner does so. This technique is used in many groupware systems. For example, there is a community which tries to identify spam mails this way. Here, spam mails are marked. The more trustful a user becomes the more his decisions are weighted [SpamNet 03].

6 Conclusions

In modern organizations especially network or virtual organizations problems occur when trying to establish a shared knowledge management for the participating individuals and organizations. A striking point here is the missing awareness of all members which leads to ignorance of the competencies the organization has. One way to improve transparency over the organization's activities are awareness systems which can be integrated into groupware systems that are mainly used for cooperation needs. The idea presented here is to use such an awareness system as part of a knowledge management tool. The goal is to give mutual orientation of the respective competencies to every team member. This is done by interpreting the events that are generated by an awareness system as competence-indicating events. A first prototype was integrated into a newsgroup system.

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