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Peer-to-Peer
Fueling Community-Based Knowledge Management

Munich Business School Working Paper

2004-02

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Peer-to-Peer Networks

Peer-to-peer (P2P) networks comprise structures of autonomous, egalitarian nodes which collaboratively share resources without relying on central coordination mechanisms. Traditional networks store data and information on centralized servers, whereas computers in P2P networks act simultaneously as clients and servers: by minimizing server workload, overall performance is maximized [6]. Initiated by the hype surrounding the file sharing application Napster, the P2P paradigm has attracted increasing attention from IS researchers. Nevertheless, the underlying concepts and promises yet remain ill-defined and unrealized. To provide a common basis for understanding we distinguish three P2P network layers [9]:

- "P2P infrastructures" provide communication, integration and translation functions between technology components and applications. Of specific interest are interoperability and security issues. The former relates to the identification of network nodes, the establishment of communication processes, and to the finding, use, and exchange of resources. The latter may include authentication and encryption features, as well as the management of access rights.
- "P2P applications" make use of the underlying infrastructure and aim to foster communication and collaboration among network nodes. All of them must provide dynamic network connectivity, i.e. each node ought to be able to form dynamic relationships with other nodes. Typical application categories include collaboration, file sharing, grid computing, and instant messaging. Collaboration applications allow knowledge workers to team up in virtual environments with features for brainstorming, event planning, and secure communications. File sharing applications allow for direct connections between computers to search for relevant files to distribute and trade. Grid computing applications enable the distribution of processing power by linking computers in vast networks. Instant messaging applications are concerned with real-time communications and pre-sence technologies.
- "P2P communities" consist of (geographically) distributed members striving for a joint interest and sharing common norms and values. Diversity and specialization are brought to bear on specific projects. Those communities lack formal hierarchies and structures; the only real status is that of member [3]. Additional qualifying characteristics may include emotional attachment, interdependence, self-organization, and trust. P2P applications form a joint interaction platform for all community members, allowing them to contact peers easily, freely, and on their own terms.

Knowledge Management Initiatives

Today's agile business models increasingly require better leverage of organizational knowledge. Knowledge management's (KM) growing complexity generates the need for creative and flexible knowledge workers with abilities for cooperation and teamwork – often across hierarchical, functional, and organizational boundaries. In turn, these dynamic organizational arrangements place new demands on supporting information technology (IT). According to Alavi and Leidner [1], knowledge management systems (KMS) are "a class of information systems applied to managing organizational knowledge. [They] create an infrastructure and environment that contribute to organizational KM by actualizing, supporting, augmenting, and reinforcing knowledge processes at a deep level through enhancing their underlying dynamics, scope, timing, and overall synergy."

In their pragmatic KM research framework, Grover and Davenport [5] postulate that knowledge processes exist in duality with a context composed of strategy, structure, people/culture, and technology. Knowledge generation, codification, transfer, and realization can either be deliberate, i.e. the result of conscious organizational KM interventions, or emergent, i.e. tied into the business processes themselves or arising from day-to-day practice. The context elements facilitate and enhance inter- and intraorganizational knowledge processes. For successful KMS rollouts, this surrounding must explicitly be taken into account. Though technology is no longer a major barrier – all necessary IS solutions already exist, e.g. databases, email, groupware, and Intranets [7] – many firms face severe obstacles in bridging KM strategy and implementation: more than half of all projects do not reach their stated goals and objectives [10]. Based on earlier discussions [8], we put forward that current KM technologies are often inconsistent with the social architecture of knowledge, i.e. the people/culture context.

A Structural Analogy Approach

While some proponents of a socio-technical KM perspective just recognize the interdependence of knowledge processes and context elements, others call for a careful balancing and optimization. Congruent with Bonifacio et al. [2] we take this reasoning a step further by proposing coherence between technology and people/culture issues. The examination complements the well-recognized task-technology fit model [4]. Structural analogies comprise a promising approach to the proposed alignment. By definition, analogies employ metaphors for examining relationships among items [11]. A structural analogy investigates the analogy between structures from different domains by mapping objects and relations from one domain to another. By mapping P2P's technological architecture onto knowledge communities' social architecture - depicted in figure 1 – the following analogies emerge: autonomy, self-organization, mutual interaction, and mutual trust.

- "Autonomy" refers to the ability for acting in specific domains without external guidance or support. In the context of KM, authority concentration inevitably reduces creativity, whereas power dispersion facilitates experimentation, freedom of expression, and spontaneity, which are the lifeblood of knowledge generation. Moreover, centralized structures hinder communication and frequent sharing of ideas across hierarchies and functions due to time-consuming communication channels; they further cause discontinuousness and distortion of ideas [12]. P2P technology guarantees autonomy by treating each node as a peer which owns local knowledge, organized and stored through local applications. The participatory environment facilitates knowledge generation through involvement: every peer is free to decide spontaneously when and to what extent knowledge is passed on.

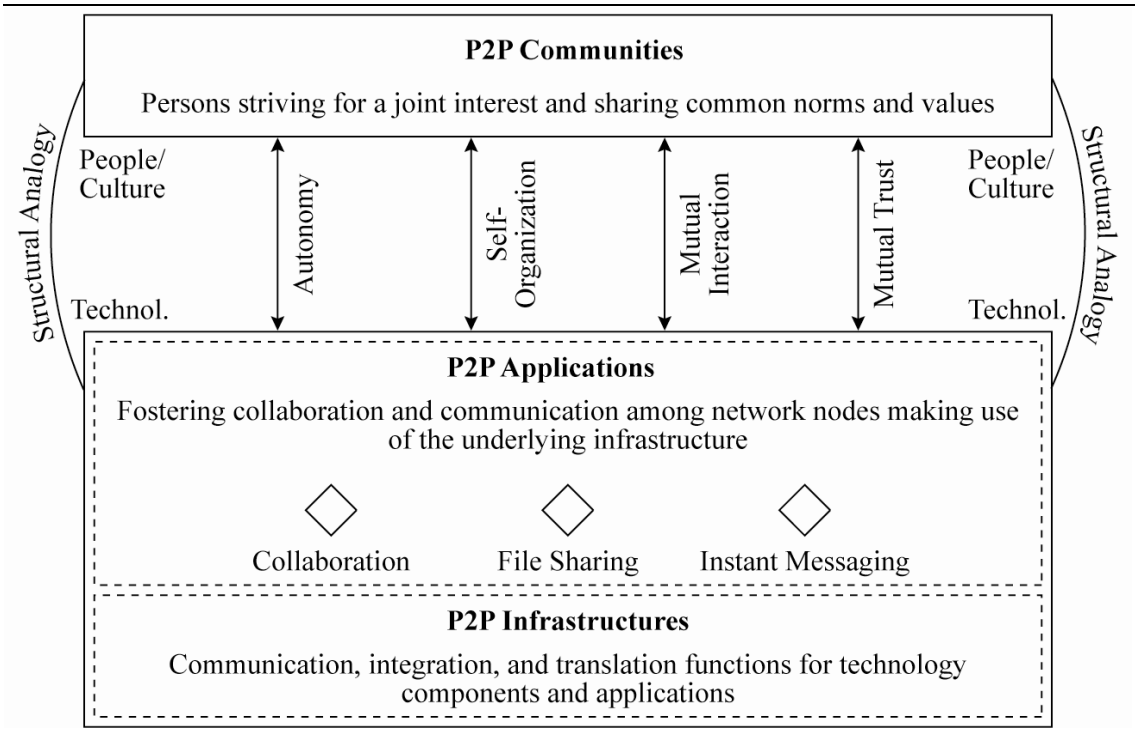

Figure 1. Structural Analogy Between P2P Technology and People/Culture

- "Self-organization" denotes the spontaneous emergence of coherence or structure without external coercion or control. Though many KM practitioners assume that organization members configure themselves as individuals without impetus from the top, knowledge communities are not reliant on central coordination or organization-bound KMS. Often they are emergent and self-constituting to facilitate solutions to existing or new problems through the generation and transfer of knowledge. Shape and membership materialize through activity as opposed to a deliberate formation for bounded tasks [3]. P2P technology offers mechanisms and protocols to facilitate the cooperative, bottom-up formation of informal communication practices and groups without a central, controlling authority [2]. Seamless scalability is a further advantage. Numerous nodes can join flexibly - across hierarchical, functional, and organizational boundaries – to work on particular business problems and disband on completion.
- "Mutual interaction" describes activities of interchanging or reciprocating. An essential characteristic of knowledge communities is that the generation and transfer of knowledge occurs interactively – often in nonroutine, personal, and unstructured dialogues – as an interdependent network. Every employee can assume the roles of contributor and beneficiary. The potential contribution of P2P technology is clear: the combination of collaboration, file sharing, and instant messaging applications to share resources (contacts, perspectives and relationships) and to establish formal and informal connections among those not working side by side [7]. Analogous to knowledge communities, nodes act as knowledge givers when they publish a body of knowledge together with an explicit semantic view (knowledge taxonomy) on it; nodes act as knowledge takers when they search for information.
- "Mutual trust" is the reciprocal faith in each other in terms of intention and behaviors. When their relationships are high in trust, people are more willing to engage in

knowledge processes. While knowledge is commonly shared with colleagues through personal contacts, emails, and newsgroups, many centralized KMS lack employee trust. Organization members fear that their contributions are used to decide on evaluations, promotions, and layoffs. In contrast to one-on-one interactions, knowledge repositories do not emphasize personal needs for information, decrease fear of uncontrolled distribution, or create moral obligations for reciprocity, e.g. repayment. Decentralized KMS with P2P authentication and encryption features, however, make use of the same principles that motivate people for the voluntary sharing of individual knowledge and skills. And even external partners can participate without breach of security.

Peer-To-Peer Knowledge Communities

We have identified structural similarities between P2P technology and the social architecture of knowledge. To leverage these analogies we propose to build P2P knowledge management applications on top of the physical P2P infrastructure to create a virtual decentralized network. P2P knowledge communities can use this network to self-organize into peer groups for creating and sharing knowledge. Complementing the task-technology fit model, we argue that is not sufficient to reach a good fit between knowledge tasks and technology features. Additional fit between people/culture and technology is needed for successful KMS implementations. Though from a technological point of view any client/server-based KMS is able to provide the same functionality as a decentralized KMS, they are not equivalent from a psychological point of view.

P2P KMS seem specifically useful for groups with a shared context because decentralized approaches cannot easily overcome a lack of knowledge taxonomies. First evidence from our pilot study in the banking industry shows that decentralized KMS can indeed support emergent knowledge networks, bringing people together for the exchange of topic-specific knowledge in interactive, non-routine, and unstructured ways. However, the interests of knowledge workers and organizations differ: while P2P's inherent cultural and psychological factors can foster active knowledge communities on an individual level, firms forego the benefits of keeping control over corporate knowledge. Only the taxonomies of top-down, client/server approaches allow for the generation and codification of a structured, organization-wide knowledge body. Without a framework for classifying information, diverse units cannot effectively talk to each other about business problems [7]. To cover all specific knowledge demands, a blend of centralized and decentralized architectures might prevail in the future.

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