

A PEER-TO-PEER KNOWLEDGE SHARING APPROACH FOR A NETWORKED RESEARCH COMMUNITY

Yang Tian, Lydia Lau and Peter Dew

School of Computing, University of Leeds, UK

Email: yangt@comp.leeds.ac.uk, llau@comp.leeds.ac.uk, dew@comp.leeds.ac.uk

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Abstract: The potential of efficient knowledge sharing in a peer-to-peer community is investigated by a case study of Journal Club with a peer-to-peer prototype developed using JXTA. As compared with the centralized approach of client/server, the decentralized approach is able to provide a more flexible environment that may be used as an addition or an alternative to share knowledge in a networked virtual community.

1 INTRODUCTION

Research communities are dynamic groups whose members create, capture and share knowledge in various ways. However, co-operation in such environments usually takes place in a sporadic fashion, as individual members are also independent agents with their own research agenda. There have been a number of approaches to provide on-line support to share knowledge in the communities (e.g. ISWORLD, web sites for various special interests groups, Koch, 2001 and Yglesias, 1998). Experience shows that sustaining such on-line communities with this centralized approach could be problematic and usually relied on the dedication from a minority of the members at the hub.

In this study, we argue that this centralized approach has its limitation. To develop a better environment, a decentralized approach has been tested using a peer-to-peer Journal Club as an example.

2 CENTRALIZED VERSUS DECENTRALIZED APPROACH

Knowledge acquisition and learning are greatly facilitated by interaction and collaboration with others (Wenger, 1998). The Information & Communication Technology (ICT) should not only provide efficient tools for interaction and collaboration, but also address the issues of privacy, security, sense of community and ownership. This may improve the way the community members

acquire knowledge and accomplish tasks (Bieber 2002).

In a centralized virtual community, the resources are held and maintained centrally at a server as illustrated in Figure 1A. Many virtual communities apply this approach to share knowledge, for example, VSP (Lau, 2001; Barrett 2000) and ISWORLD. As the resources are kept centrally, the stability and security are dependent on the server, and less computational power on the client side is needed. However, it requires non-trivial effort to duplicate information onto the server, and provides the clients with a lack of control over the information submitted. These may affect the information acquisition and update. In addition, the centralized approach tends to publish resources according to a pre-defined structure that may or may not meet individual's requirement at the time.

A decentralized virtual community assumes that all members are equal to share information. Each member will have direct control over when and with whom a certain resource is shared, and where the resource is located. As illustrated in Figure 1B, each member can contribute resources to the community and establish direct connections with any other members to access communal resources or to carry out some communal activity (Parameswaran, 2001). Current advances in peer-to-peer technology open up an opportunity to realise these goals.

As compared with the centralized approach, decentralized virtual community provides a more interactive and flexible environment to share knowledge as follows: i) each member has full ownership of the shared content, as all shared files are stored and controlled locally; ii) each member is able to know the presence of other members in the community and interact directly to another; iii) as the members are responsible for indexing their

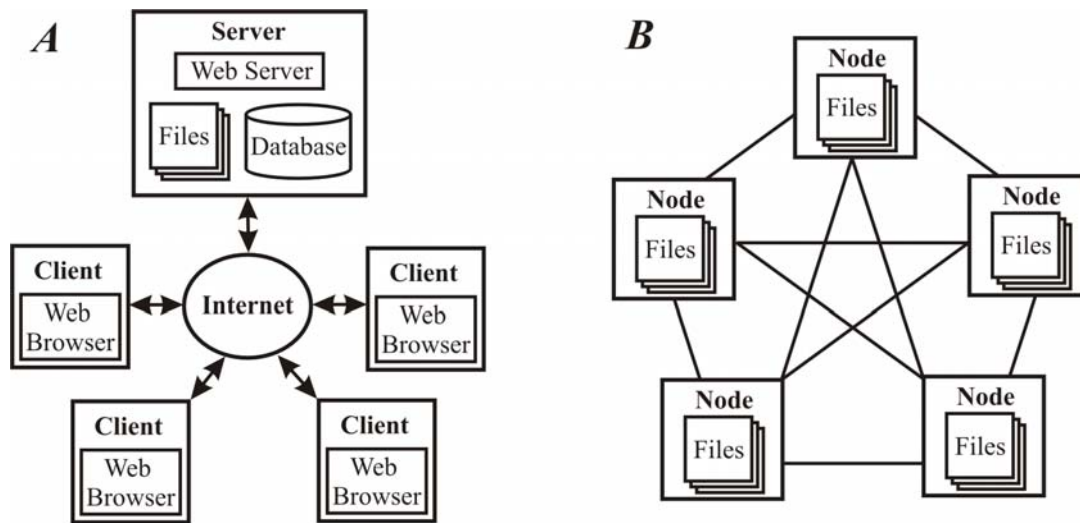


Figure 1: Centralized and decentralized approaches

documents available, it is possible to provide more accurate and up-to-date information.

3 CASE STUDY: A NETWORKED JOURNAL CLUB

To apply a peer-to-peer approach to a virtual community, there are two major issues. Firstly, relations among the members must be defined so that the related knowledge and content can be acquired and accessed via an interaction with the members concerned. Secondly, there should be mechanisms to define an appropriate ontology that helps the members to find and access to the related content. The issues were studied using a networked Journal Club that is a virtual community with geographically distributed members. The members have common interests or work on related projects and share, recommend and discuss their readings. A peer-to-peer prototype was developed to enable the community members to share and discuss their readings and recommendations. Each member was responsible for his/her resources.

3.1 Analysis of requirement

To analyse the requirement of the Journal Club, a number of typical scenarios were studied. A typical scenario is described below.

3.1.1 A typical scenario

There is a multi-disciplinary project cooperated by a company and two academic institutions:

university A and university B. Billy is a research student in University A, who joined the project recently. He needed advise from a particular expert – John in university B. Billy joined their project journal club by installing the software onto his workstation and providing the appropriate network settings to register. He found a group involved in his problem and joined the group. He also found John was online and browsed the resources recommended or deposited by John. Next day, Billy needed to clarify a point in John’s paper and chatted with John in the journal club to discuss the query. John pointed out the query could be addressed by an un-published working paper on his computer and he is happy to grant him access to it till next week. John also mentioned some people whose papers may be helpful. Therefore, Billy made a search to locate their papers.

3.1.2 Functions of the journal club

As a result of the analysis based on scenarios, the functions of the Journal Club are classified as group, share and communication.

The group is a set of functions that allow the members build and join or leave groups and/or subgroups in the Journal Club and construct the basis structure of the community in the context of their projects and/or tasks.

The share is a set of functions to support the activities of managing, reading and exchanging that enable paper searching, sharing and transferring among the members online.

The communication is a set of functions to facilitate the connections among the members. Functions under this category include discussion and

chat that reinforce the interactive feature of the knowledge-sharing environment.

3.2 Journal Club prototype

Based on the analysis of requirement above, a prototype of the Journal Club was built to test the decentralized knowledge sharing approach, using JXTA as a developing platform. JXTA is an open network programming and computing platform for peer-to-peer computing (Gong, 2001) and provides a set of basic peer-to-peer communication protocols.

3.2.1 System Architecture of the prototype

The prototype consists of a local storage and three layers: application layer, service layer and core layer, as illustrated in Figure 2.

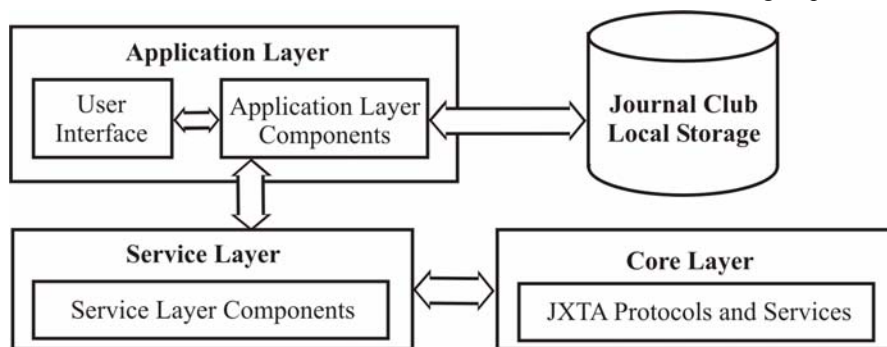


Figure 2: System architecture of the prototype

On the applications layer, a user interface and five application functions (paper sharing, searching, transferring, discussing and chatting) were implemented. The service layer is an interface between the applications and JXTA. On this layer, functions that need to be used by more than one application were implemented. On the core layer, JXTA protocols were implemented.

Each peer holds a local storage that stores JXTA local caches, JXTA advertisements, peer caches for the basic JXTA communication, basic metadata, resources and their authentication information.

3.2.2 Main components of the prototype

According to the system architecture, main components and their relations were designed as follows.

On the service layer, the group and peer communication functions for the applications were implemented; the JXTA services such as discovery service or pipe service were transformed into the

specific forms for the applications. Components on this layer are:

Peer Core provides basic services for a JXTA peer. It loads JXTA configurator for users to configure basic networking settings and join the default JXTA NetPeerGroup for its peer identification. This component supports creating, joining and resigning peer groups. JXTA peer groups are used as templates for groups of the Journal Club.

Peer Search uses JXTA discovery services to find peers, peer groups on the network.

Communication is in charge of all communications between itself and other peers on the network. This component initializes itself by creating an input pipe whose detail is then published in a JXTA pipe advertisement through out the network. It then binds the input pipe to a listener that will deal with all incoming requests from other peers

via the input pipe. The communication channels are built using JXTA input and output pipes

Listener listens to all incoming requests and responses from other peers on the network via the communication. On listening, the listener forwards incoming messages to appropriate secondary listeners.

Club Explorer was built based on services provided by Peer Search to allow a peer to monitor status of all peers and sub groups in the club.

Components on the application layer support the share and communication functions as follows:

Journal Sharing enables a peer to manage its shared papers to other peers or peer groups. The peer can grant access to its shared papers to specific peers or peer groups. It can also withhold access that has been granted before. Details of shared papers on a peer are kept on its local caches.

Journal Search allows a peer to search for shared papers on other peers that it has access to. The search is carried out based on the basic metadata, such as keywords, title and author of the papers.

Discussion Manager manages discussion messages in the club and the sub groups. Each group has its discussion board.

Chat Manager provides means for synchronous and real time communication within the club, sub groups or between peer members.

4 DISCUSSION

This work attempts to bridge the gap between our underlying theory and our practice to develop an open and flexible structure to share knowledge in a virtual community. It focuses on cooperatively building and maintaining distributed knowledge structures.

At the outset of this work, a more decentralized approach was used, which allows members to play a more active role in the activities of knowledge sharing. Our early study demonstrated the feasibility of such a decentralized concept despite of several unknown shortcomings below. Firstly, to build the networked journal club in a totally decentralized manner, the desirability of some kind of co-ordination hub is exposed, in particular, for the co-ordination of the relations among the shared resources including people and explicit knowledge. Secondly, as JXTA is still undergoing development and certain important features such as trust and security are not available. This indicates that peer-to-peer technology is still rather unstable.

In addition, our experience shows that the way forward for supporting virtual communities may be based on a combination of a light weight center augmented by some peer-to-peer connection for certain types of sharing activity.

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