SeWeb: A Knowledge Flowing Service Network Mode of Super knowledge nodes' Transmission[1] based on P2P

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ABSTRACT: *Knowledge service has not been a strange information technology since web users can actively query and serve useful knowledge. In this paper, we present SeWeb, which is an effective and efficient knowledge recommending system using classical P2P technology based on super nodes. Super nodes are users with fast, mobile connections. This paper has solved two problems: (1) how to construct knowledge services model pointing to Web application; (2) how to eliminate misunderstanding applied knowledge services on Web Platforms. SeWeb Platforms make sure of efficient information communication because of HTTP protocol. SeWeb can construct wider P2P networks (VPNs) whose goal is to serve knowledge of various kinds. Besides, we show one application interface: SeCollege, which is a sort of real time document resources provider. SeCollege users can upload or download needed documents wherever physical location is. From evaluation results, the emergency of Server Platform has brought vast, great convenience to users.*

Keywords: Knowledge flowing service P2P, SeWeb (Platform), super knowledge nodes, knowledge transmission

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1. Introduction

Knowledge service has not been a strange information technology since web users can positively query and serve useful knowledge in communities, such as organizations and institutions. Recently, peer-to-peer (P2P) network technology has received more commercial attention. Based on knowledge flowing theory, many **Web applications** and expert systems which are related to Web service have been developed for solving ad-hoc problems in life. For example, KaZaa**[1]** uses P2P technology to satisfy users. This means that individual user connects to each other (see fig.1) directly without need for a central point of management role. Literature **[2]**explains four technical advantages of P2P: decentralized control, self organization, adaptation and scalability.

The P2P Searches occur through users with fast, mobile connections, called **Super-knowledge nodes**. Once spacial located, the file is sourced for downloading directly from the user who has it.

However, in most cases users have installed firewalls and proxies[2] that will make sure they can get safe and correct knowledge services within local networks, not available beyond remote firewalls. For instance, when a professor is invited to an international conference abroad, he or she can not immediately connect to the ad-hoc proxy or local network

[1] This project is supported by National Nature Science Foundation of China (No. 2003CB317005), Shuguang Program of Shanghai Educational Committee (No. 05SG15).
[2] Proxy: a server which is authorized to act for Internet users.

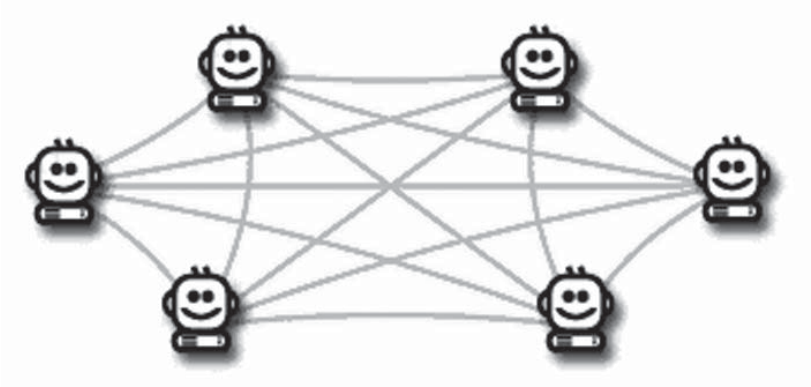

Figure 1. connecting way of P2P networks

that can be connected to his or her college's LAN via the Internet (see fig.2, troublesome knowledge service situation (1)), whose security level is high, because local networks are often protected by firewalls. Even if the professor had authority to change college firewalls' security configuration, the result is overwhelming that the secret and security of the college network must be threatened.

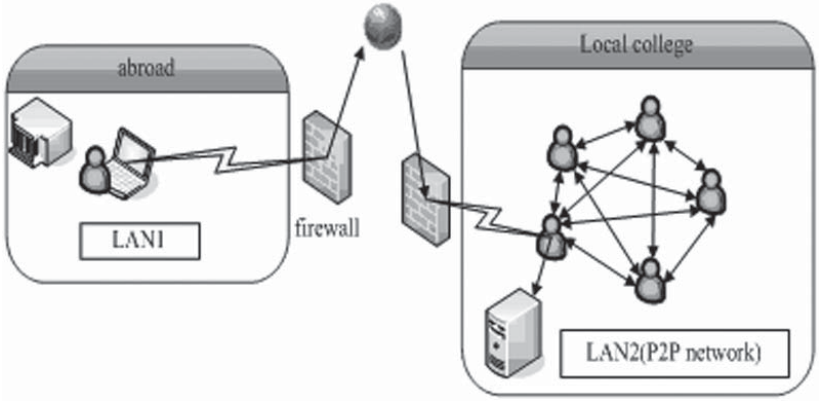

Figure 2. Troublesome knowledge sharing situation (1)

There is another bad situation, that is, sometimes abnormal semantic information can not be correctly machine-understood. For example, there is a piece of news which uses one place-name in China to tell people some event happened (see fig.3, semantic misunderstanding of Web knowledge service situation (2)), nevertheless one additional 'weather forecast service' mistakes the semantic place-name information, resulting original event content to the weather forecast about that Chinese place. Therefore, we have to eliminate this semantic misunderstanding phenomenon at SeWeb platform.

In this paper, we present a creative network transmission technology solving above problems for knowledge services on the Internet, called "SeWeb". In some certain communities, SeWeb enables users to query detail knowledge or provide knowledge services based on super node's technology, which is an active factor in ad-hoc networks: each user can enter even operate SeWeb terminal on his or her laptop, we also set up a specific platform which is called **Server Platform**. Server Platform mainly manages its users' profile and preference as a third part. At Server Platform, there is an expert agent which examines all super nodes waiting in specific room. Besides, super nodes are mobile and responsible for sending/receiving information from outside of some LAN. The information here is referred to **transmission information and semantic examination information**. Simultaneously, the former is to solve situation (1), when the information is encoded and encapsulated into a super node that can autonomously carry necessary protocol data or transmitting information; while the latter is to solve situation (2), when the semantic examination is implemented at Server Platform, then any additional services function will work as long as the result is good enough.

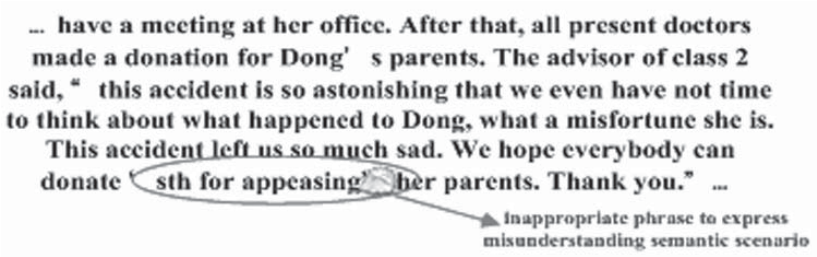

Figure 3. Semantic misunderstanding of Web knowledge service situation (2)

Since HTTP protocol is one of the most common protocols applied on the Internet (such as http://www.***.com open a webpage), HTTP protocol is always admitted to pass through general firewalls successfully. Therefore, encoded and encapsulated super-nodes also can pass through the firewalls with necessary transmitting information. Such super-nodes can migrate among different LANs, maybe larger Virtual Private Networks (VPNs). These super nodes act freely between LANs via the Server Platform. When a super node migrates to the Sever Platform among LANs, its policy and IP address are automatically obtained by the expert agent at Server Platform, which can choose an appropriate destination for the super node. At the same time, the expert agent also translate and examine the semantic service information brought by this super node to **'semantic database'** and re-express well after getting its support, then Server Platform encodes and encapsulates the new expression into the same super node. In this way, when other LAN (platform) receives this super node, it can decode the expression again and continue its services on Website.

The test of this paper is organized as follows. Section 2 presents an overview of SeWeb, including a description of knowledge services mode and detail network framework & problems. A problem solving method is present in section 3 and 4. Then, section 5 presents SeCollege, which is a document resource serving system using SeWeb platform. Section 6 presents an evaluation method of SeWeb. Related other work is discussed in section 7 and we conclude the whole work into section 8.

2. Overview of SeWeb

2.1 The content of SeWeb

Figure 4 presents an overview of SeWeb. Here, SeWeb can autonomously organize the whole P2P network between two LANs (maybe more LANs).

Firstly, there are three similar definitions we need to distinguish:

1. **SeWeb** is a creative network transmission and service conception, aiming for knowledge services on the Internet.
2. **SeWeb** platform is a kind of role use. It often consists of super nodes, also can be viewed as one specific super node. Only on this platform can users realize knowledge query and serve function.
3. **Sever Platform** behaves like a middle station where there is a 24-hour-working expert agent which examines all super-nodes waiting at this Platform. Sever Platform also decode and encode serialized information when transmission happens among SeWeb platforms.

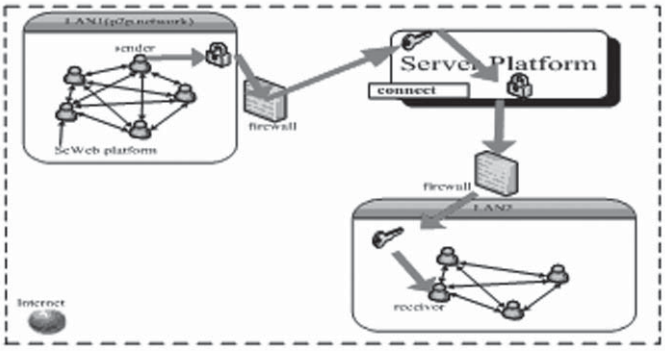

Figure 4. An overview of SeWeb

Secondly, SeWeb platform exists in two type networks, as shown in figure 4. (1) the network within LAN; (2) the network among different LANs. Actually, the role of SeWeb platform in type (2) consists of type (1). For example, in figure 4, though LAN1 and LAN2 are both protected by firewalls, LAN2 may consist of various LAN1 types. Actually Sever Platform acts like a 'phone receptor' who serves two calling sides. Basically, fig.4 is a hybrid network. Besides offering knowledge query, SeWeb can also construct ad-hoc networks for other kind knowledge services, which are described as follows:

- Automatically construct related networks.

SeWeb platforms are usually working online and convenient when a new super node wants to join in the existing networks and get needed knowledge service. The whole process does not need complicated configuration activities. For instance, we also use JmDNS [3] to send information to other SeWeb platforms. Here JmDNS is a Java implementation of multicast DNS. It can provide very fast downloads based on super nodes.

- Eliminating misunderstanding service.

It is well believed that the Internet is not panacea, there always be mistakes itself. We have given out such the 'place-name' misunderstanding as above (see fig.3). We build such Server platform at which an expert agent can annotate semantic exclusion based on context, then get the 'semantic database' support, finally select the right service function to re-express well.

- Individual naming service.

The management of SeWeb is complex in the future. However, we bring individual naming rules and digital signature technology to solve this problem. Now we are preparing for developing a quick IP address locating service that will be embedded in Server Platform. Therefore, when uniformed naming space is constructed, SeWeb can manage some ad-hoc network without physical IP address.

- Additional knowledge serving functions.

Based on users' preference, what he or she has filled up or history records, SeWeb can automatically classify related user information to the expert agent located at Sever Platform. Accordingly, Sever Platform serves additional knowledge, such as stock chart, weather forecast, transportation or business news etc. Like newest chatting software 'POPO' or MSN can provide everyday news when you open the interface in the morning.

2.2 Some service problems via the Internet

SeWeb can organize P2P networks for knowledge services via the Internet. To realize this goal and make the networks run more flexible, we put emphases on improving knowledge services problems as follows:

- Firewalls, proxies and encoded data from remote LANs. When some LAN has established its firewalls and proxies, general data access or transmission outside this LAN is not available. As we take 'the professor on abroad' example, he or she certainly can not get necessary college resource from his or her community's LAN. Even though a user has the authority to reset firewall's configuration, the secret and security will be deadly threatened.
- Providing users' IP address technology. When a user (super node) wants to send an application for knowledge services, it must provide its IP address whatever fixed or mobile. However, most users do not know the current IP address of SeWeb platform in advance, except that he or she has installed '**Maxthon** browser' or IP checking software. However, it is hard for users to preact this job. Therefore, SeWeb should dynamically get it done for users.

3. Information transmission among firewalls

3.1 Transmission Protocol HTTP between SeWeb Platforms

SeWeb platform is a kind of role use. It often can be viewed as a special super node. If we want to solve Web services problems, SeWeb platform must permit 'information transmission' go through firewalls smoothly, which is installed by every super node itself. At this moment, HTTP protocol is indispensable during the whole transmission process.

In SeWeb, information transmission between different SeWeb Platforms is completed as the start and the end of the same super node. Since general users can submit their information via HTTP protocol, the super node who wants to send service request should pass through firewalls in the way without other transmission protocols. As shown in fig.5, when a super node A is sending information to another SeWeb Platform, the information is then encoded into Byte data with Head Doc packets, which can pass through firewall via HTTP. In the same way, the Byte data will be decoded into original super node A on the destination SeWeb Platform2, then super node A can get needed knowledge services there. As we discussed in Section

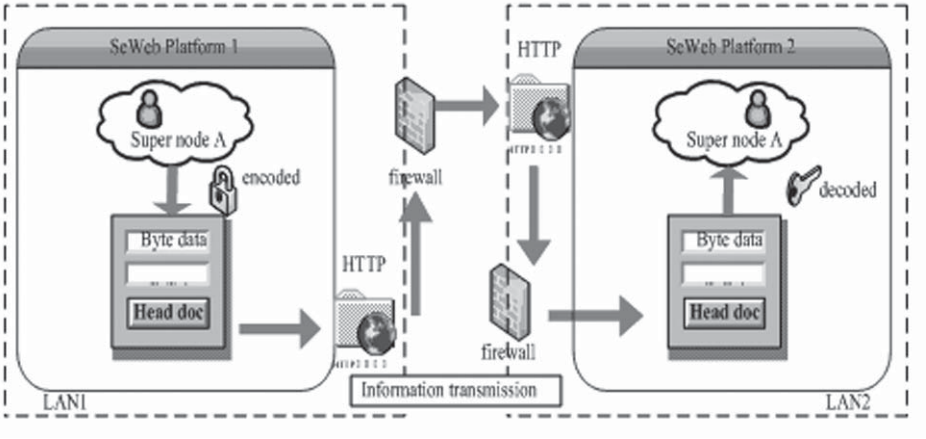

Figure 5. A transmission Protocol between SeWeb Platforms

1, HTTP protocol is a very common Internet protocol and most firewalls, if security level is not extremely high, will accept the HTTP Byte data with Head Doc packets throughout LANs. Therefore, whenever SeWeb platform is online, and HTTP protocol is available in the networks, information transmission is on secure way.

3.2 A transmission method of how Sever Platform works

Figure 5 presents how a super node can pass through firewalls via HTTP protocol. However, a super node can not enter high-level LANs because of the configuration of their firewalls. These high-level LANs are mainly research institutions, college seminar online or military organizations. SeWeb platform can be used for specific users with such high-level LANs. Therefore, SeWeb has a 'Server Platform' to indirectly connect different LANs. It can solve information transmission problem among different high-level firewalls. Super nodes reach the Server Platform, and wait for annotation by an expert agent on it. The expert agent is responsible for checking out current node's semantic information quickly, annotating it and monitoring other super nodes until the agent gets the positive response from 'semantic database'. Only semantic database can make sure the transmitting node is correct, then the expert agent sends signal to destination platform, LAN2 starts to download the super node. As we know, most firewalls permit downloading data on the Internet. So SeWeb super nodes can transmit smoothly among different LANs. Figure 6 gives out an example of super node A how it goes beyond firewalls. A detailed explanation as follows:

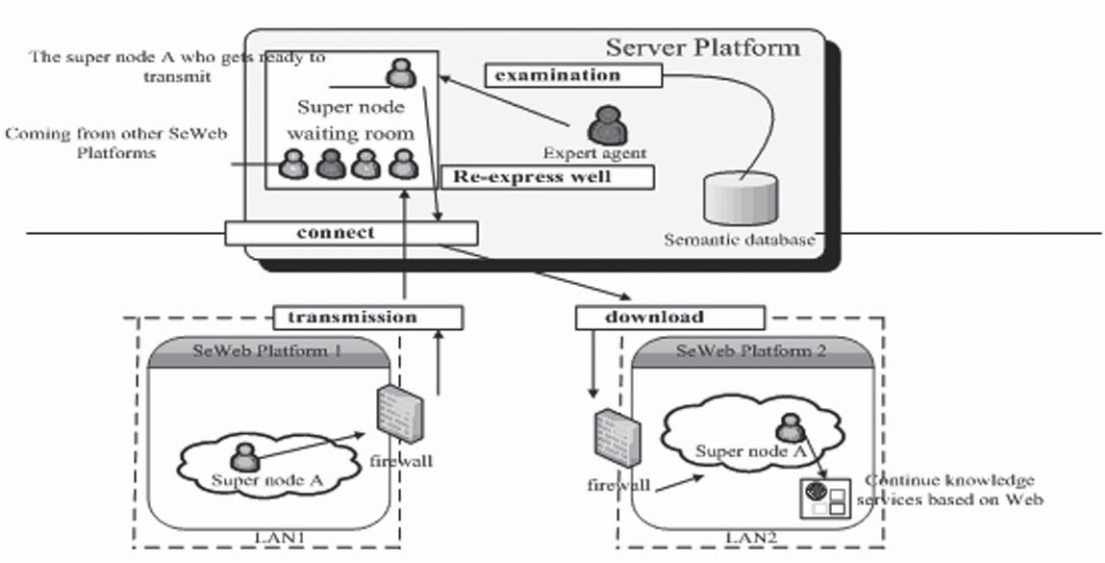

Figure 6. Transmission of super node's pathway

Step 1: super node A is ready to migrate to Server Platform from SeWeb platform 1 where node A has been encoded then sent out via HTTP protocol. Firewall will allow this encoded super node to move to the Server Platform.

Step 2: after connecting to Server Platform, encoded node A is decoded, and at the same moment there are many super nodes from other SeWeb Platforms of LANs in the same way waiting for access to the expert agent.

Step 3: the expert agent will find out the most urgent node according to its policy, annotate it while the agent is monitoring the others in waiting room. Then, expert agent translates node A's semantic service information with support of semantic database, finally through adjustability re-express service information well if necessary.

Step 4: after the expert agent understands node A wants to transmit from SeWeb Platform 1 to 2, and the re-expression is out of question. The expert agent signals SeWeb Platform 2 to accept node A. Then super node A is encoded again by Server Platform here and is downloaded by SeWeb Platform 2. Technically, the high-level firewall of SeWeb Platform 2 will prevents the access from outsides. However, it is Platform 2 who requests to download the encoded node A after it accepts expert agent's confirmation, so encoded node A can successfully pass through.

Step 5: SeWeb Platform 2 decodes the super node A which has done its transmission process and next step, continue to get some necessary knowledge services.

It is believed that in this section, we assume all super nodes can pass through firewalls all the time, not go back in the middle way. Another assumption is that Server Platform is always online working and can quickly get every waiting node's IP address automatically during examination even if the IP address is mobile.

4. How transmitted information determined by expert agent

When a user (super node) wants to send request for knowledge services, it must provide its current IP address whatever fixed or mobile. However, most users do not know the current IP address of SeWeb platform in advance except that he or she has installed 'Maxthon browser' or any IP checking software. Obviously, it is hard for common users to do this job. Therefore, SeWeb should dynamically help users get it done, and the expert agent at Server Platform will automatically determinate suitable requesting super-node.

Figure 7 describes how the expert agent dynamically determine to select suitable super nodes (A to E), let it pass through Server Platform and signal to destination SeWeb platform (see fig.6). At right side of Server Platform, each SeWeb Platform (1 to 4) stores its policy information into 'policy list' when it starts to accept one super node. At the same time, all super nodes in the waiting room convert their request into XML docs, store them into 'request list' with fixed format, such as <Head::super node name> <Location::SeWeb platform name> <Request::1,2,3…>. Then, according to 'request list', the expert agent begins to search from 'policy list' and do the annotating and matching job. Certainly, the matching process may be more flexible and intelligent than simple annotation. For example, a dialogue could happen between two sides (platforms) and expert agent will play a role of negotiator. If a request from 'request list' can offer appropriate information which matches the corresponding policy from 'policy list', this request-sending super node will be finally chosen and allowed to be downloaded by its destination Platform.

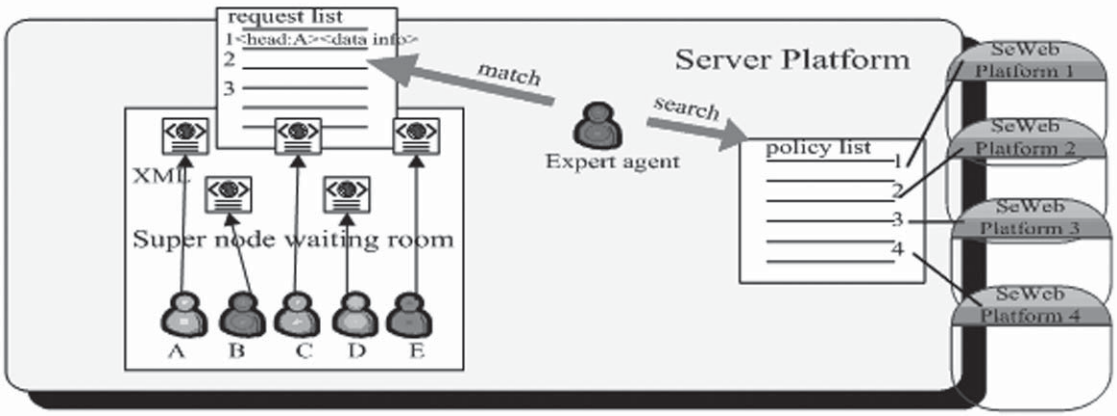

Figure 7. The expert agent examination on the Sever Platform

According to this method, expert agent at Server Platform can act as a communicator among SeWeb Platforms that belong to different LANs (VPNs). Besides, this method brings a third part, called 'expert agent' into the information transmission process. It successfully avoids checking out current IP address trouble.

- **SeCollege: a document resource serving system based on SeWeb**

SeCollege is a series of knowledge serving applications based on document resources. On SeCollege, users (super nodes) can view, select, comment, review and manage authorized document resources. For example, when the professor abroad wants to download a piece of important paper that is just stored in remote college's FTP, he or she surely can successfully get this knowledge service with the help of SeCollege, even if he or she is on the other side of this Planet. Through the interface of figure 8, this requirement will be fully satisfied.

Furthermore, users can also upload their newest documents, including profiles, blogs, academic papers and personal experience & ideas etc. what is more important is to manage all knowledge resources well whatever he or she is local or remote. By using SeWeb, users do not need complicated method and configuration to achieve their goals. Fig.8 shows a snapshot of SeCollege's interface. Current documents (papers) results are listed on the left page after searching 'grid services' and 'similarity' keywords at remote College's database or personal FTP. Users can select one or more papers to view summary, download or check out detailed information. Besides, as we can see the right side of the page, a user can access other online users and download their resources after getting their permission. Furthermore, college news is recently updated at the right bottom. The best coincidence is that when you have found the appropriate paper, the authors are also online, you can easily obtain best knowledge services by chatting with them.

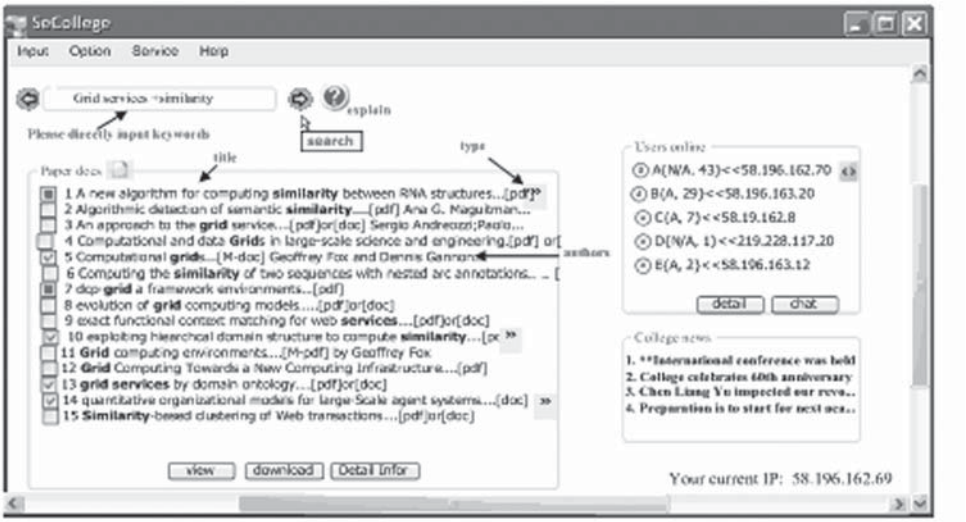

Figure 8. The snapshot of SeCollege

In addition, SeCollege has the following features:

(1) Metadata conveniences knowledge services
SeCollege uses metadata of document resources because of the great convenience. For example, title, authors, the type of paper etc. are main metadata of such services. When SeCollege has loaded on remote server or college FTP, it can automatically extract necessary metadata from PDF or DOC papers. Therefore, this can quickly attract user's attention on the right place.

(2) Portability
SeCollege is a kind of small and smart application software. It can even be installed in mobile entity like MP4 or PDA. Thus, users can carry SeCollege interface with SeWeb function and knowledge services. As long as a user can connect to the Internet whatever he or she uses systems, laptop, MP4, cell phone or PDA, he or she can download and upload ample document resource.

(3) Strong searching engine
SeCollege has correlation thesaurus based on query words' semantic similarity. With the thesaurus, SeCollege automatically compute the matching level and similarity of current keywords and resources which are stored in college database in numerical terms. This service function is gorgeous because it has applied semantic analysis technology.

(4) Knowledge recommending service

According to some user's searching historical records, SeCollege can recommend him or her related papers or news documents. As an additional service, Quality of service (Qos) [8] of SeWeb function contains specified knowledge acquisition. Certainly, SeCollege need to get users' feedback (e.g. a score of 1-10 scale, 10 is the best) about each paper or news he or she has viewed.

5. Evaluation

5.1 Simulation experiment setting

With the help of Server Platforms, SeWeb can serve P2P network, even larger VPNs well, we have to make an evaluation of Qos at platforms (SeWeb). The effect and efficiency are main parts of SeWeb's performance factors. In this section, we try to measure delay level of transmitting information on SeWeb Platforms, including upload and download released time.

Firstly, because the expert agent on Server Platforms examines whether there is appropriate super node which carries the right decoded request information, annotating and asking if to move to another Server Platform, we conclude that the more platforms (expert agents) in networks, the heavier delay of information transmission, upload and download time will become. Additionally, more super nodes migrating among different Server Platforms at the same time, the heavier loading work the 'semantic database' will endure.

Secondly, we use Origin6.0 to simulate the elapsed transmitting time by changing the number of SeWeb Platforms **(details please see figure 9)**. Here we assume that SeCollege (see Section 5) particularly stands for a SeWeb application, the size of each node is just made up from multiple bytes of metadata. In another experiment, we also use Matlab7.0 to simulate the elapsed transmitting time by changing the number of super nodes that are moving simultaneously **(at least 10 super nodes, more detail please see figure 10)**.

Thirdly, the number of Server Platforms needs to be considered as well when scope of knowledge services expands to VPNs. Therefore, we made the third simulation work to test the relationship of elapsed transmitting time and Server Platforms **(please see figure 11).**

In the end, we also scrutinize the relation chart on elapsed transmitting time when changing the number of SeWeb, super nodes and Server Platforms. **Figure 12** describes our expected situation successfully and proves it.

5.2 Experimental Results and Analysis

Fig.9 demonstrates the elapsed transmitting time (vertical axes) varies by changing the number of SeWeb Platforms (horizontal axes). The total elapsed time overwhelmingly increases when the number of SeWeb Platforms grows from2 to 50, and keep up at some level, approximately 5331(m-sec). This is because when more load happened on SeWeb Platforms, super nodes' transmitting time of sending/receiving increased. However, we can see clearly that at horizontal axes scope [40, 50], the growth of elapsed time became slowly. And when there were more than 50 SeWeb Platforms, there was much less influence on the moving super nodes, besides little influence on total elapsed time. Therefore, when the scale of SeWeb users (platforms) is large enough, the total transmitting time will not be a trouble.

Fig. 10 shows the elapsed transmitting time (vertical axes) varies by changing the number of super nodes (horizontal axes) which all move at the same time. We can see the elapsed time nearly increases fit linear to the number of ascending super nodes. In other words, this trend is not like what Fig.9 demonstrates exponentially increases. When horizontal axes reaches 80, the vertical axes almost keeps about $1.428*10^{\wedge 6}$ sec. Therefore, compared with Fig.9, the effect about elapsed time on super nodes is more than twice that on SeWeb Platforms.

Fig. 11 explains that the elapsed time (vertical axes) varies by changing the number of Server Platforms (horizontal axes) that act as a middle transporter. This can be easily understood from the chart that elapsed time decreases as the number of Server Platform grows. Because Server Platform plays a connecting part among different SeWebs, one Server Platform charges at least two SeWeb Platforms and the rest may be deduced by analogy. Besides, the curve is similar to Fig.10 that fits linear but negative. Finally, when Server Platforms reach approximately 100, the total elapsed time will be reduced to $0.4*10^{\wedge 4}$ (m-sec).

Figure 12 uses a 3D model to describe the relationship among elapsed transmitting time, the number of Super nodes and Server Platforms. In detail, elapsed time (Y axes) varied by changing the number of Server Platforms (Z axes) and Super nodes (X axes). Obviously, we have to simulate reality, set the number of Super nodes as Log curve exponentially increases, we found a rule that the number of needed Server Platform is approximately half that of Super nodes. Typically,

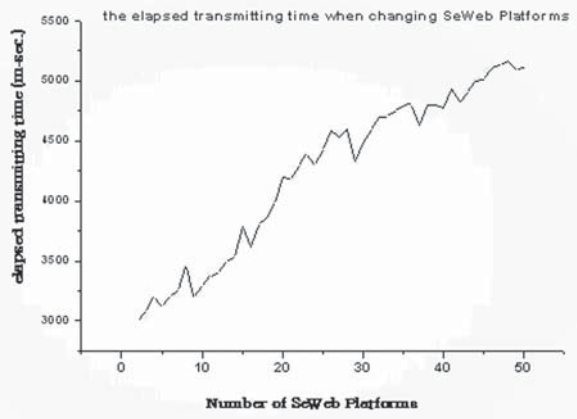

Figure 9. Elapsed time with ascending SeWeb Platforms

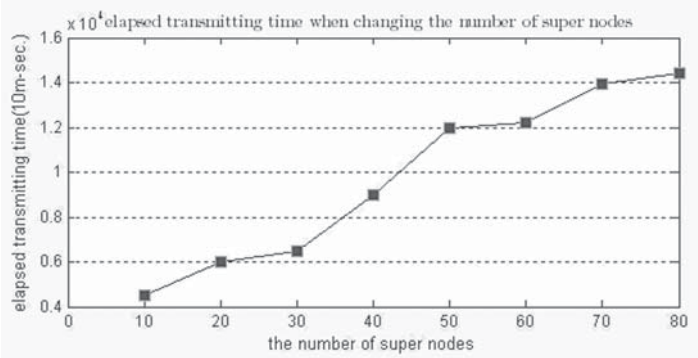

Figure 10. Elapsed time with ascending super- knowledge nodes

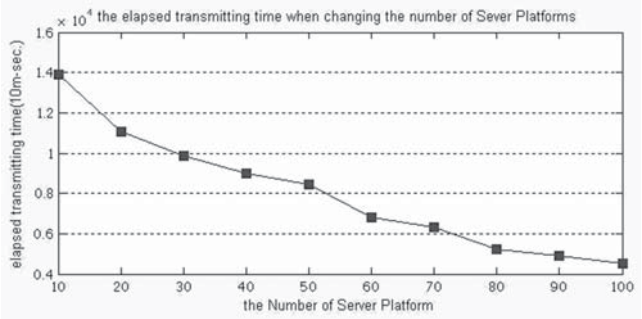

Figure 11. Elapsed time with ascending Server Platforms

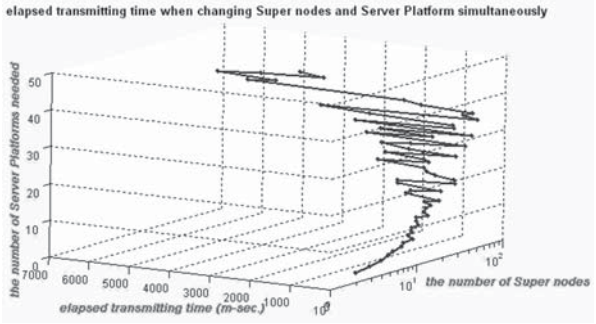

Figure 12. Three-Dimension chart of total elapsed transmitting time

a big fluctuation happened between Z [39, 47] when Super nodes is near to 80. Then, the total elapsed time trended to keep steady, approximately 5300 (m-sec). When Super nodes arrive at 100, Y axes almost varies nothing. At this level, the number of Server Platforms is 45.

6. Comparisons with previous works

There exist some other P2P systems online, such as KaZaA[1] and Gnutella[4] etc. Users of these Websites are mainly provided file services about music, video photos exhibition or making friends etc. Definitely, these functions all belong to knowledge services. However, for one thing, none of the websites can provide document resources downloading while users are especially remote loading. For another thing, there are no good P2P systems that can connect other systems beyond firewalls. Because of the emergence of Server Platform, our SeWeb is not a pure P2P server system. Instead, SeWeb is indeed composed of many pure P2P server systems, for instance each LAN or SeWeb Platform can be regarded as a pure P2P system. There are also many other P2P systems though not typical such as Chord [5], Pastry [2] and Tapestry [7].

From fig.13, we draw the conclusion that only under SeWeb mode, can information transmission speed and organization's secret & security be highly exerted. In other three situations, even if there is LAN (Broad Band, BB) or firewalls respectively, its' security & secret and information transmission speed are not satisfactory.

7. Summary and Future

In this paper, we have presented SeWeb, which is an effective and efficient knowledge serving system using classical P2P technology based on super nodes. This paper has two goals: first one, how to construct knowledge services mode and its frameworks

pointing to Web application, for example we built up SeCollege for providing document resources service. The other one is that SeWeb uses an expert agent to eliminate misunderstanding after getting support of semantic database that locates at Server Platforms. Super nodes, which also can be viewed as SeWeb Platforms in VPNs, are to send/receive encoded and decoded information during whole transmission process. Though current larger LANs make sure of efficient communication because of HTTP protocol, in SeWeb, it is super node that is automatically annotated and matched to its appropriate destination platform according to their policies. Actually, SeWeb did construct wider P2P connecting networks whose is serving knowledge of various kinds. For instance, 'google map' (http://bendi.google.com/) is a special map and location service tool.

Besides, we have showed an application based on SeWeb: **SeCollege**, which is a sort of real time document resources provider. Because SeCollege is run on SeWeb, its users can get any satisfactory knowledge services (e.g. to download papers and scan news) at any time anywhere.

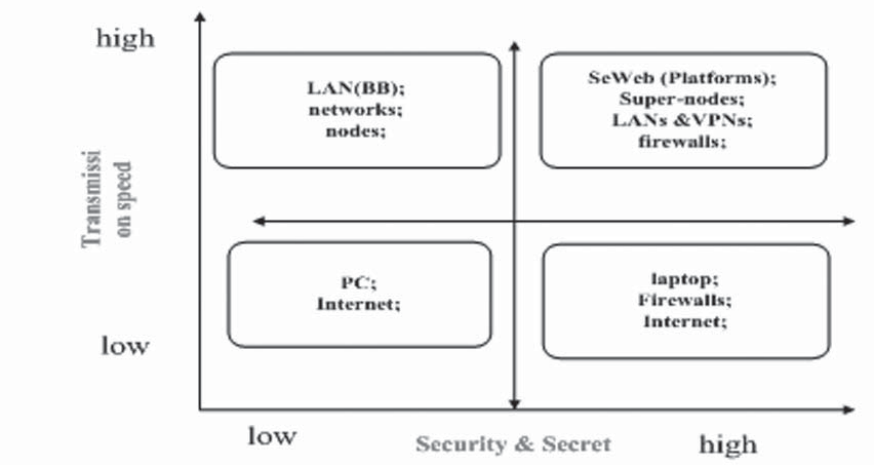

Figure 13. Comparison advantages in different net-environment

Finally, we have also evaluated some main factors that can influence the whole scalability of SeWeb. They are elapsed transmitting time, the number of super nodes, Server Platform and SeWeb Platforms (LANs). Through simulation experiments, some useful results were:

(1) When the number of Server Platform is approximately 100, the total elapsed time will be reduced to 4.3 sec.

(2) When the number of Super nodes reaches 100, there is almost no distinct variety. At this moment, the best number of Server Platforms is 45.

Therefore, we believe that SeWeb do not need too many Server Platforms to make the whole LANs (VPNs) operate well. And, the influence on total elapsed time is quite small when a lot many super nodes are transmitting simultaneously.

A future work and direction of this study is to consider what SeWeb should do in more complicated situations when quite a lot super nodes are all suitable and appropriate to destination platform's policy. And we will carefully explain how the authorization work, then give out dynamic optimistic selecting algorithm on super nodes' information transmission.

Acknowledgement

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