A knowledge sharing and collaboration system model based on Internet

Wu Gangshan* Huang Yuan* Shian-Shyong Tseng Zhang Fuyan***
***State Key Laboratory for Novell Software Technology**
Department of Computer Science and Technology, Nanjing Univ.
Nanjing, Jiangsu 210093, China
{gswu|fyzhang}@netra.nju.edu.cn, hy@graphics.nju.edu.cn
****Department of Computer and Information Science**
National Chiao Tung Univ., Hsinchu,Taiwan
sstseng@cis.nctu.edu.tw

ABSTRACT

This paper proposes a knowledge sharing and collaboration system model (InKB) based on Internet. It gives a way to collaborate and share knowledge between Web-based knowledge systems. InKB model has three layers, Data exchange layer, collaboration layer and knowledge-based application layer. Data exchange layer solves the problem of how to represent and manipulate knowledge. Collaboration layer devotes to collaboration between servers over Internet. Knowledge-based application layer defines the user interface for knowledge processing over Internet, such as information searching, decision-support application and data mining. Data exchange between InKB Webs is in XML format, knowledge can be shared between heterogeneous knowledge bases, and knowledge can be remotely manipulated. Collaboration between InKBs is supported through collaboration agent, which can find resource user wants in InKB system. As an open system model, InKB can also support HTTP request such as information retrieval and browse.

Keyword: knowledge base, Internet, knowledge sharing, collaboration.

1. INTRODUCTION

With the explosive growth of information source available on the World Wide Web, more and more people are used to get information from Internet. Many applications are developed based on Web architecture, such as information retrieval, WebDB and so on. Knowledge based system on Internet is now paid close attention and is accessible more widely than ever before. On the other hand, Web server needs more intelligence, so that it can do more than just as a resource supplier. Based on client/server model, Web server is independent each other. There is an increasing need for powerful mechanism to share information and/or collaborate between Webs.

Being in HTML form, information from Webs is suitable for browsing and retrieval. With regard to knowledge process, HTML is not good enough for representing and manipulating knowledge. Besides, sharing and collaboration is another problem to construct knowledge base over Internet. In this paper, we propose a knowledge sharing and collaboration system model based on Internet called InKB. In this model, data communication between servers is in XML format, so InKB also can be used among heterogeneous environment.

2. WEB-BASED KNOWLEDGE BASE ARCHITECTURE

Today the WWW is widely accepted and easy-to-use environment for information system, Knowledge based systems profit in many ways from this new technology [1][2][3]. It is common to setup knowledge base on Web server, and knowledge on server can be accessed through low-cost Internet browser all over the world.

But it is almost impossible to save all the knowledge information on a server, and even only for a special domain knowledge information is too large to store. Therefore that several collaborating servers setup a complete knowledge base seems to have emergency need. In other words, a single server can not process wide range knowledge request from client user, and can send the request to special knowledge base system to process, and then return the result to client user. It seems to be a good idea to both knowledge base system and client user.

To reach the goals we mentioned above, the mechanisms listed below are required to connect distributed servers:

1. Mechanism to communicate between several Web-

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based knowledge bases,

2. Protocol to exchange knowledge between several Web-based knowledge bases, and
3. Mechanism to collaborate between several knowledge based servers.

Based on above consideration, we propose the architecture as show in Fig1 to share and collaborate between knowledge base.

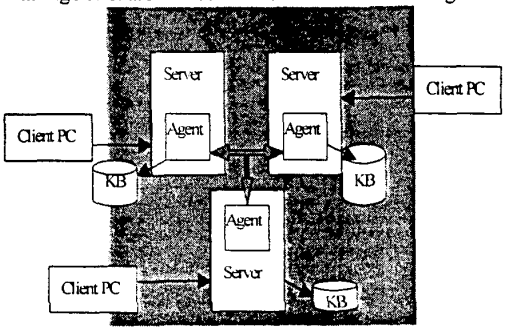

Fig 1. Knowledge sharing and collaboration system architecture

In Internet environment, servers are distributed and dynamically configured, so communication between knowledge base servers is very important. In fact, in our proposed architecture every server has communication agent, which serves as bridge between other existing servers. In order for collaboration, a server should let the other servers know what it can do? What it has? How to do it? Users only contact with a server, and can do everything they want, even if the server itself can not deal with their requests. Server can divide user's request into several parts, which can be processed on several different servers.

In our architecture, knowledge sharing between knowledge base servers has three levels. The first is lowest one which can only share same domain and same structure information; second level can reuse information in same domain with different structure; and the third level can share general information between servers, without any strict limitation in special domain or special structure information. The higher level a server has, the more additional task processing agents it should has.

Collaboration application can be in synchronous or asynchronous model [4]. In this paper, we are only concerned with synchronous model. We don't think asynchronous model is suitable for collaborating servers in Internet environment, even though reconfiguration should be done when a server is down. In Internet environment, servers can act as different role when collaborating:

1. Loosely connected servers

   Knowledge process operations are only executed on single server. If a server can't deal with user's request, it can simply act as a bridge to transmit the request to the server that can deal with the request. This may be useful when user don't know where to find his solution. This kind of server is called loosely connected server.

2. Tightly connected servers

   Task can be finished through cooperation between servers, not just finished by a special server. If user's request can not be processed by a server itself, the server can divide this request into several parts, assign them to suitable server, merge the result from respective server, and then return it to user.

Tight collaboration between servers always means domain dependent, different request should be processed in different way. There may be many applications on a server to fulfill various kinds of knowledge sharing and collaboration on Internet.

3. THREE LAYERS InKB MODEL

In InKB model, Web server has three layers to support knowledge sharing and collaboration, which is depicted as below:

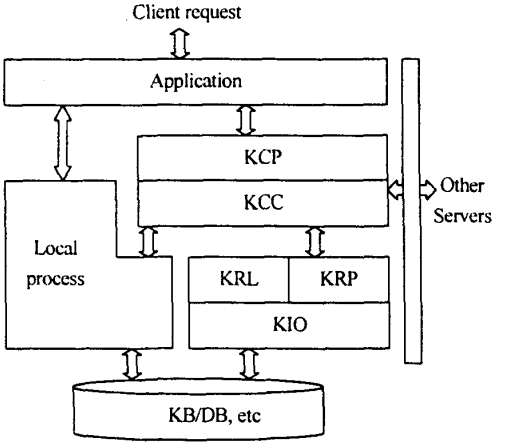

Fig 2. InKB's three-layer architecture.

Fig2 shows the main components in InKB architecture. It consists of data-exchange layer, collaboration layer and application layer. Data exchange layer solves the problem that how knowledge is represented and how to get it. Collaboration layer devotes to collaboration between servers over Internet. Knowledge-based application layer defines the user interface for knowledge processing over Internet, such as information searching, decision-support application and data mining. Three layers are connected by interface between them, and each layer is also composed of special agents to fulfill special task.

3.1 Data-exchange layer

As we know, information in Internet server are usually organized in directory like structure. Based on this structure, knowledge base on Internet server always has its own data storage, such as RDB. In InKB model, in order to share knowledge between servers, the knowledge transmission format should be specified.

Many Web-based systems just support remote access through Internet browser using HTML. It can be seen HTML is only suitable for information browsing, but gives poor semantic information about encoded context. XML, an extensible markup language, is usually used to markup structure document. Using XML, user can define meaning-full tags to markup context. To save rich information of context and to encode it in widely acceptable form, XML seems to be the better solution than HTML to represent knowledge information between collaborative servers. In InKB, shared tags which are used to markup knowledge information are defined in several DTD files according to XML specification 1.0 [5], each DTD is defined to represent special domain knowledge information which can be processed by the collaborative servers.

In InKB, server can store knowledge information in private format in local disk, but knowledge communication should be in XML form, this results in converting module in each server. Data-exchange layer in InKB is charge of converting knowledge information into XML format. Data-exchange layer consists of three components, KRL (Knowledge Represent Language), KRP (Knowledge representation Parser) and KIO (Knowledge Input/Output). KRL component deals with knowledge conversion from private format to XML, KRP is in charge of conversion from XML to private format, and KIO maintains input and output process in local knowledge base.

Data-exchange layer can send interface specification DTDs to upper layer and collaboration manager server, and let them the server's resource. The interface follows the syntax below:

[action][data]

Such DTD file may look like:

<!element action (browse | sort | write ...) >
<!element data (format, item+)>
.....

Data request can be in XML file following the above DTD's syntax:

<action><browse/></action>
<data>
<format type = "1" ><if/><then/></format>
</data>

Server returns data in requested format from local knowledge base. Although interface may be different from server to server, specification of all interfaces should be recorded in collaboration manager site.

3.2 Collaboration layer

The second layer in InKB is collaboration layer. This layer consists of components to support collaboration between knowledge base servers, which have knowledge collaboration control component (KCC) and knowledge collaboration process (KCP). KCC can find the information of all InKB servers available over Internet, find what those server can do, and also find how to do it. KCP component deals with user request from application layer or other servers and calls corresponding function on local server to fulfill it. Therefore, in Fig2, there is a local process module proposed to accomplish local knowledge process. Depends on implementation, all those components may consist of several agents to fulfill task.

There is a manager server in InKB, which is in charge of keeping track of information about all servers in InKB system. When new server comes on or a server is done, manager server will update information of all servers. New server can contact with manager server to get full information of others, and also introduce its information to others via the manager server.

There are two communication formats between servers in InKB system. One is in DTD format, which is used to submit server's function specification to manager server, and let other servers know and utilize it; the other is XML format, which is used to send request to appreciate server. The functionality of new server will be sent to manager server in collaborative environment, and this may be done several times when there are many functions in this server. According to DTD's syntax, InKB server sends request in XML file. Function specification DTD consists of three parts as following:

[domain specification][action][data]

Such DTD file may look like:

<!element InKB_Service (domain, action, data) >
<!element domain #PCDATA >
<!element action (func1 | func2 | ...) >
<!element data (input?, output)>
<!element input (format, item+) >
<!element output (format, item+) >
.....

In the above sample of DTD, other servers should be familiar with this DTD; otherwise, the function defined can not be utilized.

Request from one server to another is in XML form. Following is a sample of collaboration request file:

```
<domain>Student graduate rule base</domain>
<action></judge type="graduate"/></action>
<data><input><format type="1"/>
        <item>Jack Wang, 89, 90, 60,... </item></input>
</data>
```

In above example, user wants to know whether Jack Wang can graduate or not. According to domain and action information in the above XML file, server receiving this request may use the rule in local rule base to make a judgment, and return the judgment result to requester.

Collaboration layer also has interface to Application layer, which provides retrieval function of all resources in InKB system. Knowledge based application on InKB server submits collaboration request to other server through KCC module, then KCC module on other server returns results to the requester. Resource request may be from user or application's internal process.

3.3 Application layer

The third layer in InKB is application layer, which directly deal with user's request and fulfill various knowledge-based processes. Application can use collaboration functions supported in several servers to complete a complex task. Application layer also has interface directly to data-exchange layer, if user's request can be processed locally, application can directly use knowledge on local machine.

Based on InKB, knowledge sharing and collaboration in application layer can be in different operating modes. In first mode, In order to process user's request, application needs knowledge on other servers. In second mode, application submits user's request to suitable server through collaboration layer, and returns request processed results to user. In third mode, application divides a user's request into several parts and submits them to different servers, then collects the returned results and merges them into a combined conclusion.

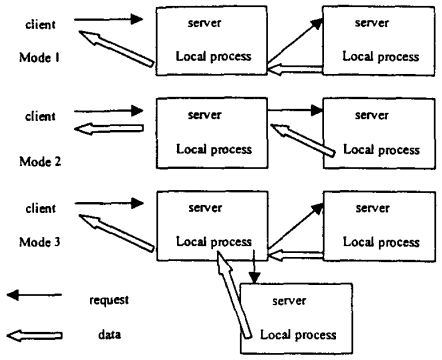

Fig 3: Three modes of collaboration in application

4. KNOWLEDGE PROCESS SAMPLE BASED ON InKB

Suppose there are A, B and C three servers in a bank, which is connected through Internet. A is collaboration manager of those three servers, each server has different function and local knowledge information.

Example: a man whose information is saved in server C, he applies a VIP card to server A, but only server B has the knowledge about how to deal with VIP card business. Routine to process this request is:

1. the man sends his request to server A,
2. Server A finds that it cannot process this request, and through A.KCC find that server B has VIP process function registry, then server A submits this request to server B.
3. B.KCC asks A to find client's information, and then asks server C to return client's information.
4. Server B processes client's request according to local knowledge and client's information, and then returns result to server A.
5. Server A returns result to client.

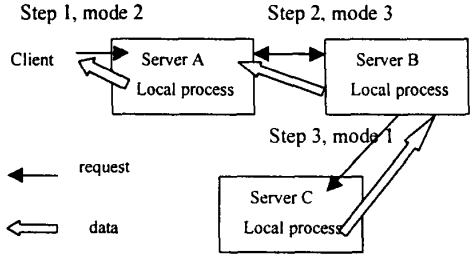

Fig 4. The example request process routine.

All three modes are included in this example. When client sends request to server A, but A cannot process it, then transmits request to server B for answer, this is in mode 2. Server B first asks server C for client information, this is in mode 1, and then

processes the A's request, this is in mode 3.

5. MODEL EVALUATION AND RELATED WORK

In InKB model, knowledge sharing and collaboration between Web-based servers are divided into three layers. In fact, not all three layers are needed in a certain server. For example, without application layer, server also can work in InKB system. The server doesn't process client request, but can process request from other servers. All communication information between servers are in XML form, this W3C standard can make InKB platform independent, so knowledge sharing and collaboration can be done within heterogeneous environment, such as UNIX, NT and so on. In addition, InKB is compatible with Web architecture, so InKB server can supply general HTTP services.

The main features of InKB are open, dynamic configuration and scaleable. Open makes InKB feasible to heterogeneous environment, especially on Internet. InKB can be accessed by various kinds of tool available on Internet. Dynamic configuration makes InKB system robust to any change, collaborative system always need to deal with this issue. Scaleable means InKB server can be multilevel implemented, that is to say, not all three layers are needed in a certain server, server without application also can work in InKB system.

Research on Web knowledge base has been paid more and more attention now. Research about knowledge sharing in Computer Science Department of Stanford University touches many aspects of knowledge sharing and collaboration mentioned in this paper. They proposed specification like KQML, KIF and so on, based on those specification application has been setup. But all specification is defined in special form, and is not widely accepted like XML.

[6] proposes a rule-based system IMVEX, which can be controlled and manipulated over Internet environment, this is similar to InKB's knowledge sharing mechanism. In IMVEX, client is just a terminal, only can display result server processed, and collaboration issue is not mentioned in that paper.

[7] introduces EDEN project, which develop and demonstrate means for sharing and using environment data over Internet. The infrastructure of EDEN system is based on InfoSleuth intelligent agent technology [8]. EDEN is very like InKB in knowledge sharing, but it doesn't deal with collaboration between Web servers.

6. CONCLUSION

This paper proposed a knowledge sharing and collaboration system model based on Internet. This model can be used to setup knowledge based system on Web. InKB Web server can also support HTTP request. Many issues about knowledge sharing and collaboration are still not touched in this paper, such as agents communication mechanism, transaction issue when collaborate between servers and so on. Future work will focus on those issues.

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