P2P Distributed Cooperative Work Model Based on JXTA Platform

Gao Bao-Qing, Fu Xiu-Fen, and Xu Su-Xia

School of Computer, Guangdong University of Technology, Guangzhou 510075, China

Abstract. Distributed cooperation work system performs more effectively than a centralized cooperation work system in many aspects. In this paper, we analyze the existing problems in cooperation work models nowadays, and then present a P2P distributed cooperation work model based on JXTA platform, which can greatly simplify the development of distributed collaboration work system and enable the system possess of better scalability, platform- -independence and flexible applicability. At last, we obtain an analysis compared to other models and make suggestions to improve the model.

Keywords: CSCW JXTA P2P Distributed Collaboration Concurrency Access Control.

1 Introduction

P2P (peer to peer) is becoming a research hotshot in recent years because of its characteristics such as load balancing, robustness and self-organization, etc. Especially in the CSCW, it gives us a more attentive selection than Client/Server and traditional distributive architecture. Nowadays some business applications based on p2p have appeared in market, including Skype and Microsoft Office Tool Groove. The cooperative application based on p2p can satisfy various cooperation demands with a more natural and cute manner, which is especially suitable for mobile office environment. On the basis of analysing traditional CSCW model, this paper obtains a distributive CSCW model based on JXTA and makes detailed discussion for its layers and working theory, more detailed analyses to the policies used in the model at last.

2 CSCW Model and Existing Problems

CSCW[1] is computer supported coopera- -tive work, which means that exhausting computer and communication technology to support geographically dispersed workers to cooperate in a common task. CSCW system can be divided into two classes: centralized and distributive architecture (also called all coping architecture).

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2.1 CSCW Model

In fact, centralized architecture means Client/Server (or Browser), as shown in Fig1, this architecture is generally composed of one or more servers and more clients interacting with servers, at the same time, which transforms operation events produced by users into instructions that can be recognized by servers and sent to servers to be executed in a unified fashion. At last, servers dispatch and execute these operation instructions, then return processed results to clients to display. Because all processes are centralized in one or a small quantity of servers, collaboration management and Real-time cooperation's concurrent access control can be easily realized

In distributive cooperation architecture, the original functions of servers are balanced to more clients, so that every client has double identity, which enable free interactions between clients (peers) to manipulate their common collaborative task. Every client (peer) only receive cooperation events and execute them in local machine, so the entire collaborative application will gain more rapid responses, but concurrency access control will be more complicated.

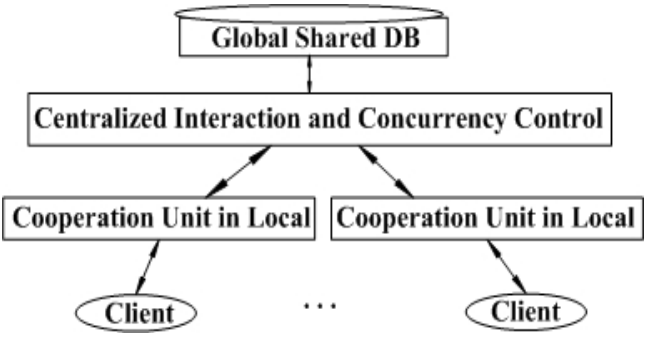

Fig. 1. Centalized CSCW architecture

2.2 Existing Problems in CSCW Model

So far, most of CSCW application systems are based on Client/Server (or browser) [2], such as Microsoft Exchange, IBM Lotus Notes and etc, but the fault of this architecture is obvious. For example, when transferring a mass of multi-media data, the performance of server may be the bottle-neck of a system. The display of Clients' collaborative operation result will be lagging in the environment severely requiring real-time interaction where shared operated object is located in a server. Distributed cooperative architecture is able to support load balancing and get better responses effect. On the other hand, data redundancy in p2p distributed system can avoid single point failure to ensure robustness.

P2P network is a kind of typical DCE (Distributed Computing Environment). Peers, PeerGroup and other conceptions defined in JXTA especially accord with essential characters of CSCW. For example, communication between peers

corresponds to collaboration between group members and PeerGroup to work-group in realistic life. The collaboration work based on P2P solves the problem of Architecture Mismatch [3] between traditional cooperation architecture and cooperation view provided to users.

3 JXTA Technology

3.1 Simple Instruction About JXTA

JXTA is a new technology proposed by SUN Microsystem according to the fault of current p2p system. JXTA mainly supplies fundamental services needed in p2p application in order to establish a general p2p distributed computing platform, so advanced p2p distributed service and application can be built in a simple but effective manner. JXTA adopts two layered topology network using super node frame, through its core p2p protocols, by which a virtual cross-platform ad-hoc network can be easily built over current physical network facilities, as shown in Fig.2.

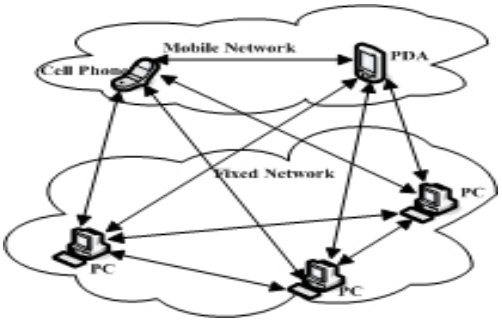

Fig. 2. JXTA virtual all connected network

3.2 Key Conceptions in Developing p2p Distributed Application Using JXTA

JXTA IDs: In the JXTA address mapping model, every resource in network has a unique JXTA ID which is generated while a peer is built. In p2p network, cooperation service and shared operated object are recognized and searched by JXTA IDs.

Peers: A peer may be any entity which can interpret core protocols defined in JXTA. Peer can be thought as an equal priority collaborator.

Messages: Message is a basic unit of transferring data in communication between peers. Peers interact with each other by sending and receiving messages. Two formatted messages, XML and binary messages, are supported by JXTA, developer can make a choice according to different requirements.

Peer Groups: Peer Group is a self-organized team composed of some peers by common interest or a common collaborative task. A Peer Group is actually a dynamic peer set which can penetrate firewall and NAT (Network Address Translator) to support communications between heterogeneous networks, as shown in Fig.2.

Pipes: Pipe is a kind of virtual communicating channel between JXTA service and application. Two peers are connected by a pipe, in which peers' data stream flows. JXTA supports different kinds of pipes to fulfill various p2p communication scenes.

4 P2P Distributed CSCW Model Based on JXTA

This paper proposes a CSCW model based on JXTA, which is used to describe the whole structure and functional layers, as shown in Fig.3. In the model, fixed computing facilities are configured with J2SE JXTA and small scale or mobile devices configured with J2ME JXTA. In the next section, the paper will make an instruction about every layer and detailed analyses on concurrency access control unit used in the model.

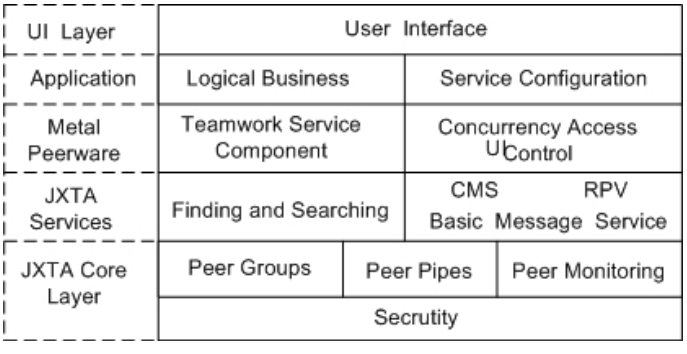

Fig. 3. CSCW model based on JXTA

1) The last two layers are JXTA core protocol layer and fundamental p2p service layer, which provide many important bottom services including peer monitoring, peer finding, shared resource distributed index and etc. In p2p network, every peer dynamically enters or exits and peers aren't able to identify remote peer (mostly because of NAT), so safe problem is outstanding comparatively. JXTA provides a relatively perfect safe frame including network security include user login based on account and password, the authentication infrastructure, simple visit control, encryption and TSL/SSL. Especially for peers running on J2SE or J2EE which support a more perfect security frame.

2) The third layer is composed of groupware[1] components and concurrency access control module. It is not geared to the needs of concrete application, but used to supply some universal cooperation functions like concurrency access control, priority control and interactions between sites that are implemented as fundamental services, so developers make use of this developing concrete cooperation application. Teamwork

Services Components are fundamental elements to realize collaboration such as Publish/Subscribe, file sharing and exploring and asynchronous message service. The concurrency control module is specifically designed for the deficiency of JXTA in the field of real-time coordination; concrete comments will be stated in next section.

3) The fourth is application tier, which includes business logic and service configuration module. Logical business layer is implemented by Java Bean, which mainly contains a business logic adapter. According to different cooperation models (including dialogue model, process model, activity model etc.) ,users can use service configurator to set related groupware components to support changing cooperating requirement, making business implementation without considering details of cooperation implementation.

4) The toppest tier is user interface adapter which is mainly used to provide users with visual service interface. Considering that, when users play PC or other mobile devices their computing capability will be distinctly different, so this tier provides different interface visualization API according to the type of device.

4.1 Model Feasibility and Characteristic Analysis

1) Using JXTA as a fundamental platform in developing p2p distributed application, on the one hand, developers can shake off the complicated job building the frame from the beginning and have more time to be absorbed in developing all kinds of novel and creative applications; On the other hand, the combination of JAVA and XML enables JXTA to be powerful enough to make the interaction between vertical applications. At the same time, to solve the digital producer copyright problem that gravely restricts the development of p2p, JXTA packages the supporting copyright administration and the core function used for centralized peer management, which makes the developing of successful business application become possible.

2) Benefit from using layered structure, when requirements dynamically change, what we need to do is only to revise business realization, because that groupware layer only cares for realization of p2p cooperating in bottom tier, the business logic care for business realization only. Also, when there is any change during the realization of cooperating model, it will not affect the above realization of business logic. By this design, to some extent, most developed component can be reused.

3) The P2P technology is famous for Napster sharing music, at present most P2P applications are confined to the sharing of documents basically. The design of JXTA is also affected by this idea more or less, so that, JXTA does not provide a comparatively perfect concurrency access control mechanism of real-time collaboration. Therefore, the fourth tier of figure3 has added a concurrency control module specially.

At present, most centralized CSCW models mainly use the traditional concurrency control policies [2] which mainly includes two kinds: (1) serial method; (2) lock method including optimistic lock and pessimistic lock; Because traditional methods come from distributed database concurrency control algorithm which does not consider interaction of user interface and only are designed for no-interactive transaction process system, so if the policy is used in groupware system, unnatural Human- --computer interaction, Machine-Machine interaction will be brought on inevitably, and it will block the user interface also.

4) According to above-mentioned problems, Ellis.etc proposed a new kind of concurrency access control method based on Operation- --Translation in 1989. In this algorithm, all operations are defined to a set of partial order relations. For two any operations, such as A and B, if they are interdependent in term of a causal relationship and A keeps ahead B, then, they have this partial order A->B and vice versa. Disordered concurrent operations are allowed, but corresponding translation is necessary according to the relation between operations in order to keep the consistency of sharing operation object in different sites. But in actual application, sometimes, it's very difficult to get all translation rules between all operations. So, this method is not suitable for all circumstances.

The model adopts a new kind of tree-based concurrency control policy [5], every peer maintains current shared operation object by this tree-structure in local. In fact, this tree is document object model DOM structure (Fig.4), any programming language can use a corresponding XML interpreter to transform a application document into this form, this method of work is feasible therefore.

In the process of real-time coordination, every site (peer) preserves the times of operation (logic clock [4]) handled in local. When receiving operation messages from other sites, the site uses its local logic clock to make a compare with the logic lock of the sending messages from source site. if the former is not smaller than the latter, then we think that logical concurrency operations mentioned in last section has occurred, now, the corresponding arbitration module generates a total order of concurrency operation events according to these events' priority, at the same time, the total order message with higher priority is sent to other sites to ensure that operations are executed in the same order in every site, thereby, entire concurrent operation control is achieved.

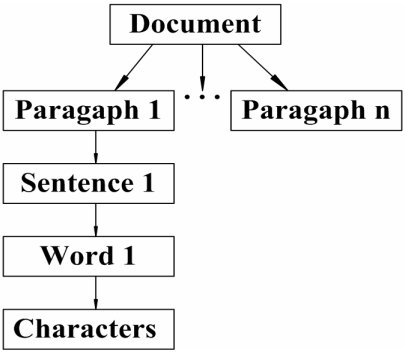

Fig. 4. Tree-structured document model

In this concurrency access control policy, the shared operation object is presented in a tree-structured form, so it has a common adaptability and can control the concurrent granularity freely. By doing this, using this method, the system has more rapid responses and better interactive nature. Currently, using this model, a simple cooperative text editor has been implemented, as shown in Fig.5, in order to validate

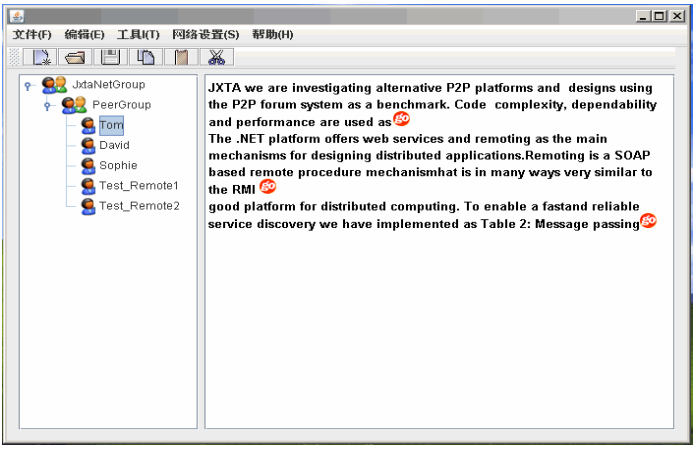

Fig. 5. p2p cooperative text editor

the applicability and performance while handling complicated interactions, a coordination image editor system will be built next step.

5) Verification of model's function and applicability: In order to verify the model's response time and its applicability when network scale is increasing, experiment has measured peers' average response time under the condition that network works on different flow load and has different total nodes. Test configuration parameters as shown in table.1, in which different peers may run on. the same host.

Table 1. Configuration Parameters

Ordinary peer	Pentium 4 2.0G, 512M Memory OS: Windows XP sp2
Rendezvous peer	Celeron 1.7G, 512M Memory Linux 2.4.1s/Federa-Linux 5.0
JXTA Build(all pees)	JXTA 2.4.1
JDK Build(All peers)	JDK 1.6 Hotspot VM

Considering that network scale is limited, only one rendezvous peer is configured. According to the experiment data, we got Fig.6. We can see that when message sending (simulating collaborating operation) frequency declines and the network flow load decreases, peers' response time is shorten. At the same time, the whole performance of the system upgrades as the increasing of network scale (by adding nodes). This is just one of the most different characteristics from Client/Server architecture, and that's the priority of P2P.

6) Existed problems with the model: Every peer is equal to another peer in role, the mechanism work better for peer cooperation though it may be not suitable for

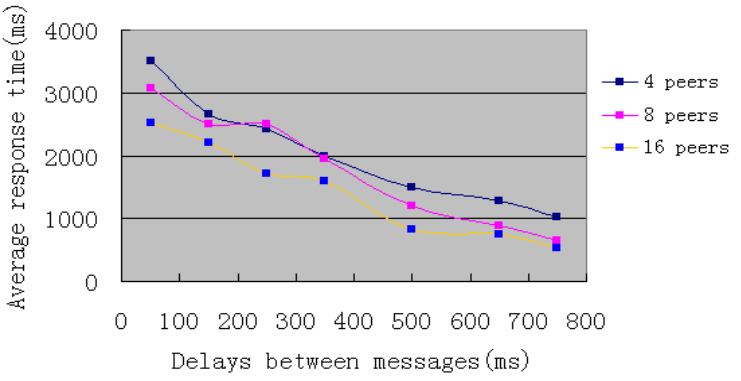

Fig. 6. Response time comparison

cooperation with relation of dependence. So some corresponding improvement to this problem is necessary. For example, the management mechanism based on role will be considered to be added to enhance the applicability of the model. Moreover, the P2P network topology is dynamically changing sharply, which may confront with problems that routine software system does not have. All of this need deeper researcher in future.

5 Conclusions

By the analysis of existed problems in current CSCW system and JXTA's advantage in developing p2p distributed CSCW system, we propose a CSCW model based JXTA, by which many bottom-tier communication details developers confront are shielded. Besides, according to deficiency in handling real-time cooperation, concurrency access control unit based tree-structure is led into the model to get more rapid user interface responses. Research priority next step is: Improving JXTA network's efficiency in data transmitting, makes the model be able to have certain error detecting and error correction ability during the period when exception happens in collaboration.

References

1. Shi, M., Xiang, Y., Yang, G.: The theory and application of CSCW[M], Publishing House of Electronics Industry, Beijing (2000)
2. Hauswirth, M., Podnar, I.: On P2P Collaboration Infrastructures. Infrastructure for Collaborative Enterprise. In: 14th IEEE International Workshops, pp. 66–71 (2005)
3. di Milano, P., da Vinci, P.L.: Peer-to-Peer for Collaborative Applications. In: Proc. Of IEEE Distributed Computing Systems Workshop, pp. 359–364 (2002)
4. Lamport, L.: Time, clocks, and the ordering of events in a distributed system. Communication of the ACM 21(7), 558–565 (1978)
5. Ionescu, M., Marsic, I.: An Arbitration Scheme for Concurrency Control in Distributed Groupware,[C]. In: An ACM CSCW 2000 Workshop. Proceedings of The Second International Workshop on Collaborative Editing Systems, Philadelphia, PA, vol. 12(3), pp. 329–350 (December 2003)