Research on a hybrid architecture model based on point to point

Dongliang Zhang*, Shaohui Zhang

Computer Science and Teaching, Zhoukou Normal University, Zhoukou 466001, China

Abstract

In light of the existing problems like the high price, complex configuration, too much cost to maintain in the collaborative design system, this paper points out a collaborative design framework under the environment of P2P. The framework adopts the design idea of the hierarchical models which divides the system is divided into the user management module based on the browser/server mode and the collaborative work module based on P2P. The former mainly addresses the task decomposition and node management problem, and the latter exerts the role of the transmission strategy and the conflict management strategy. The examples show the advantages of the new system high quality, high security, and high efficiency.

Keywords: Collaborative design system, Hierarchical, Task decomposition, Conflict management.

1. INTRODUCTION

The concept of CSCW appeared in 1984. Since then, through intensive research and wide application, CSCW has helped industries and entrepreneur of the world create enormous economic benefits. The traditional distributed collaborative design system all use the C/S model, which provides collaboration for group members of group through a functional server (Su, 2015). It can provide a shared work area and achieve the sharing of information and documents. However, the system structure is inflexible and inelastic in nature. The more collaborative users there are, the stronger the server function need to be. Beyond that, the collaborative application generally has shortcomings like high price, complex configuration and high maintenance costs etc. I later diverse demands resulted in the appearance of new applications. Now collaborative design (Suh et al., 2014) of network not only involves massive information, but also contains static pictures dynamic videos and so on. Bringing more and more pressure on servers, so the possibility of single point collapse is getting higher. Therefore the present research has shifted its focus to how to effectively use the idle high-performing hardware resources of the network and how to design a network model that enables the network to provide high quality, high security, and efficient service.

The rise of P2P has given the opportunity to make changes in the Internet. P2P has broken through the traditional C/S mode. It makes the status of every node the same, and also makes the role and function of the server less important. It makes the information and service flow between the peer entities (Yang et al., 2013; Dong and Martin, 2017; Wu et al., 2017). Thus, this paper uses P2P technology to solve the shortcomings like high price complex configuration and high maintenance costs of the conventional collaborative application systems. However, the P2P mode makes it difficult to manage customer.

2. INTRODUCTION TO RELATED KNOWLEDGE

2.1 Introduction to P2P

P2P is a distributed network. The participants of the network share the part of the resources they have. These resources can be visited by other peer node without passing through the middle entity. The participants of the network are not only the provider, but also the recipients of the resources. P2P break the traditional C/S mode. In this mode, nodes are peer to peer. They not only act as server that serves other nodes, but also share the services of other nodes (Tang et al., 2015).

2.2 P2P feature

1) They are spontaneous in nature.
2) P2P is more efficient than a single, centralized server when the system structure of P2P contain many distributed service providers.

3) The users can be providers or consumer of abstract services, and often they the consumers play both these roles.

4) The application of users may use any equipment at any time and in any places, and are cross-operating systems, cross-language and cross-network.

5) The application of users are changing constantly, so they may not be visited in time at a particular point.

2.3 Main application of P2P

First, a main application of P2P is instant messaging. In a broad sense, the end-to-end products of instant messaging products can be classified as P2P applications. Text message, voice messages and video information are the main transmissions in the end-to-end products. These products include, ICQ, Tencent QQ, Microsoft MSN and so on. Second, another mail application of P2P is resources sharing (Zitzler and Thiele, 2014). Representative file, downloading software in the resource sharing field are emerging one after another, such as BitTorrent, eMule, Kaza and domestic thunder etc. However, P2P is rarely applied in the collaborative fields.

3. CONCEPTUAL COLLABORATIVE MODEL BASED ON HYBRID STRUCTURE

Currently, most collaborative design system is based on C/S. With the continuous development of computer hardware, the levels and scale of collaborative work keep escalating. And the C/S structured system are starting to encounter many problems, for example, the network congestion is becoming more obvious, the quality of the service does not match with the hardware equipment, and the loading capacity of servers is restricted. of course, C/S also has its own many advantages, like, the control over the consistency of the local data, the centralized management and the security of data. The appearance of P2P has changed the situation of instant messaging and file sharing. Thanks to this technology, the file download speed is becoming much faster. Besides, as uploading and downloading happen at the same time, quantities and kinds of resources are greatly enlarged. However, there will be some problems when P2P is introduced to the collaborative design field: how to discover other nodes, difficulty in effective user management, no consistent arbiter for the nodes participating in collaboration and no assurance for the consistency of data at all local nodes. If there is a large number of users, data at any node must be transmitted to other nodes, which will cause the excessive data transfer, making it hard to ensure security.

Because of the above reasons, this paper presents a hybrid P2P structure, which uses the B/S mode structure to manage users, release tasks and identify collaborative workgroups and uses the pure P2P structure to complete the tasks. It divides nodes into different groups. The main function of the collaborative design part is to provide users with a collaborative development environment, process all communications at collaborative nodes and coordinate the conflicts between collaborative nodes, so as to make the collaborative development go on smoothly.

4. DESIGN OF THE CONCEPTUAL COLLABORATIVE MODEL BASED ON THE P2P STRUCTURE

4.1 Definitions

In actual design, we can divide one task into many subtasks at the same time, and set a series of interface rules and design requirements for each subtask according to the intrinsic coupling degree, the context and also certain standards and prerequisites.

1) Task Tree: the whole big task is the root node, which has successors, but no precursor. Among the M nodes except the root node, each is a task tree and can be broken down, as shown in Figure 1.

Each node in a task tree is a task tree. Generally speaking, there are several kinds of tasks as follows:
a) Atomic Task: in the collaborative design process, tasks that cannot be divided or do not need to be divided can often be finished by task groups lying at the leaf nodes.

b) Relevant Task: such a task is related to the tasks at the same level in the process. Completion and design conditions of other tasks at the same level are needed to finish the task.

c) Independent Task: the completion and design condition of other tasks at the same level are not needed to finish the task.

2) One Operation Record. One operation record includes the task number, group number, user number, operation object, operation and operation time.

4.2 Design of user management

The design of the user management module uses the B/S architecture, which consists of the following four modules:

A) User Registration Module: including user registration information, such as knowledge structure and participant’s design fields, etc.

B) User Information Browse Module: showing some user information, such as the user’s knowledge structure, tasks he/she has participated in and the collaborative task he/she is currently involved in. The user information browse module is mainly designed to make the users, who have been assigned tasks to, find the team members they need.

C) Join invitation and request module. It can invite not only other users but also related experts to join the task. At the same time, the users who do not get the task can make requests to the leader of the group to join the group and carry out the collaborative design work.

D) Task release module. Users not only can launch a task on it but also can browse the released tasks there, so that they can find the tasks they would like to join in. All users need to register their own accounts and fill in with some personal registration information. Only after registration, will the user information appear on the user information browse module, and moreover, he/she will have the following authorities: releasing tasks, asking others to join his/her group, asking to join other groups and inviting the users that appear on the user information module.

Figure 1. Task tree

After releasing each task and setting up his/her own group, he/she can use the collaborative work module to hold a meeting to decompose the task. As shown in Figure 1, each task can be divided into N tasks according to the degree of coupling. When each group member release the task again, he/she can invite other users to join in based on the user information on the user information browse module. By repeating the above process, he/she can keep decompose the task until it is broken down to a certain size. As shown in Figure 2, each group consists of a leader, M members for design, some experts and some members from other groups related to the design task.
4.3 Design of the collaborative work module

The collaborative module is mainly used for the collaborative work of users to ensure the collaborative process goes on normally. First, it is related to role and authority, and then, it adopts two strategies - transmission and conflict management. As the nodes are not stable in the P2P network, this paper puts forward a node management plan.

4.3.1 Role and authority

In the collaborative design process, the collaborative users can be approximately classified into the following five kinds: designer within the group, designer outside the group, expert, machining worker and leader. Each kind of users correspond to a role, so there are five roles. Authorities are approximately divided into six kinds: user management, data management of the design model, creating and deleting detailed design information, modifying detailed design information, viewing detailed design information, and viewing the model interface and shape information.

The relationship between role and authority is a one-to-many kind. The role of leader has all the authorities. The role of group designers has all the authorities except submitting the design model; the role of designers outside the group has the authority to view model interface and shape information; the role of experts has the authorities to modify and view the detailed design information of the model; and the role of the machining workers has the authority to view the detailed design information of the model.

4.3.2 Information hierarchy model

Task boundaries: the parts of two tasks directly connected are called task boundaries. The collaborative task development teams of two related tasks share task boundaries.

After completing work breakdown, some experienced developers define the task boundaries of the coupled set and incarnate these task boundaries by the rules or constraint conditions, eventually forming rule files. Of course, every peer node has a tiering engine to handle these rules. When a team is in development, they first download the rule files of the current task on the collaborative design site and save the information. In the design process, when the designers add, modify or delete an object, it immediately checks whether the operation is on the boundaries of two tasks through the tiering engine. If yes, it is necessary to transfer the operation information to all the peer nodes of the related task development groups; and if not, nothing needs to be done. The needed information is transmitted effectively to the required nodes by the tiering engine, with the specific design information hidden, and in this way, the hierarchical information is achieved.

4.3.3 Design of the transmission strategy

In the traditional collaborative design system, for any designer, all the design data and information are visible and also modifiable to him/her. In fact, this designer is just interested in the parts related to his design. At the same time, all people share all the data models designed, which makes information insecure and results in large amount of data transmission in the network. This paper divides the data information transmission model in collaborative design into two categories:
a) Model detailed design information: in the collaborative design process, any operation at any node will be converted into an operation record, which will be transmitted to collaborative nodes through news. All operation records of a group show the whole picture of the collaborative process. The nodes participating in the collaboration are very sensitive to any operation of other nodes, so they need to know all the design information.

b) Model interface shape information: in the collaborative design process, any operation about interface and appearance information must be converted into operation record, which will then be transmitted to collaborative nodes through news, while related internal operation records will not be transmitted. But those nodes participating in collaboration are just interested in interface, shape and function, and do not care about the internal detailed design information.

In the collaborative process, this paper uses such transmission strategy, which divides users participating in the collaboration into two types: with regards to the roles who have the authority to view the detailed design information of the model, this strategy transmits it in under the detailed design information transmission mode. With regards to the roles who have the authority to view model interface and shape information, they care most about interface and appearance information. They can check if their internal group design matches with these interfaces but do not care about the internal detailed design. For them, this strategy transmits the information under the interface appearance information transmission mode.

4.3.4 Design of the conflict management strategy

In the traditional collaborative design system, all operation information can be handled in the server, which is equivalent to a mediator. In the P2P system, it is important to ensure all the nodes synchronize. Here we suppose that the time for all nodes is consistent, that is, the error is \( \Delta t \). This paper proposes two ways:

a) Delay. It represents the time it takes for one computer to transmit a piece of information to another one. When a server is considered as the authority of the client game environment, for the client, it will at least take 1/4 second for its input to be confirmed and fed back. After this concept is introduced in the collaborative design, all information will be given a time stamp \( T_a \). Suppose within a certain time \( T_t \), any node can send information to all the nodes in the group. After any node receives the message, it will not execute any operation until \( T_a + T_t \) later.

b) Priority. Priorities are designed for different users according to different situations. Suppose the experience of a user is \( E_x \), and in a project group, the number of modules that a node has participated in is \( N_m \), the time for which he/she has been cooperating with the group members is \( N_g \) and the evaluation value that the group leader gives is \( C_g \). According to the experience gained in the actual design, the author assigns weight values \( W_1, W_2, W_3, W_4 \) to a few parameters and then obtains the priority value, which is \( E_x W_1 + N_m W_2 + N_m W_3 + N_m W_4 \). During the time from \( T_a \) to \( T_a + \Delta t \), it is believed that it sends out the information at the same time.

In this paper, delay and priority form the conflict management strategy, which is used to solve the problems in the collaborative design process.

4.3.5 Node joining

Authorization has two main functions: authorizing the user who wants to join the group to enter the design group, and checking if other nodes are the users of the group.

When a user carries out a design, he/she needs to ask the group leader to allow the node to join the design group first. The manager allows the node to join in and assign the corresponding role according to the situation of the node, forms the authentication strategy, transmission strategy and conflict management strategy in the group and copies these strategies to each user node. The group leader has the right to update the authentication strategy, including deleting the nodes in the group that participate in the design, and then announcing it in the group.

When each authorized user logs in the collaborative design system and the working group, and then makes a request to all online group members, the group members will authorize him/her according to the local group authentication strategy and send the newest related design change information to the login user according to the transmission strategy. They use the local conflict management strategy to manage the design conflicts between local nodes, and at the same time, compare the current situation of the latest design with the recent
design status in local records and copy the previous operations, and then carry out the collaborative work together with other group members.

### 4.3.6. Collaborative node management

In the collaborative design group, a group manager is designed to check in real time if the users are online. If the users find other nodes disconnected in the collaborative work, the group manager will send request information at a set interval, which contains the latest updated numbers. A node is considered disconnected if it did not receive request information in a period of time and it needs to log in the working group again and carry out update checks. If a node receives request information in a period of time, the node will check the newest updated information. If the information is not consistent, it will automatically disconnect and log in the working group again; and if it is consistent, normal feedback will be sent to the leader.

The above discussion is carried out on the prerequisite that the team leader remains the same, but in fact, group manager is not stable. After a group manager is offline, the online node that the group leader gives the highest evaluation value will become the new group manager. When other nodes log in again later, they send requests for free evaluation value node of the group leader. If it receives request information and finds the manager not online, the node will directly become the manager. If it receives request information and finds the managers online, the node will reply to the corresponding request information.

### 5. ANALYSIS OF OTHER COLLABORATIVE SYSTEM ARCHITECTURES

This paper compares the collaborative design system based on the P2P model with that based on the traditional C/S structure and finds that the server under the traditional C/S model participates in the client-side design and the processing data quantity is very large. For example, if there is a large task, where \( N \) represents the number of subdivided and atomic tasks, \( M \) represents the average number of nodes that participate in each atomic task, \( I \) represent the average number of operation records needed for each atomic task and \( P \) represents the ratio between the number of operation records needed for each atomic task and the total number of operation records. The results are shown in Table 1 - \( M \) is far greater than \((1+P)\), so the amount of data processed by nodes in the P2P system is far less than that in the client based on the C/S architecture. At the same time, the extensibility of P2P is stronger than the C/S mode. Because P2P has no middle server, any participating node need not consider the loading of the system. By grading and grouping, many data and information are designed and shared within a certain range, and in this way, the system security is improved.

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<thead>
<tr>
<th></th>
<th>C/S structure</th>
<th>Grouping P2P structure</th>
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<tr>
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<tr>
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<tr>
<td>information amount</td>
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<tr>
<td>User node processes</td>
<td>( N<em>M</em>I )</td>
<td>( M<em>I</em>(1+P) )</td>
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<td>operation record amount</td>
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<tr>
<td>Node distributes</td>
<td>( N*I )</td>
<td>( M<em>I</em>(1+P) )</td>
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### 6. CONCLUSION

This paper presents a new architecture of collaborative design in the P2P environment, discusses how to establish the collaborative design system in the P2P environment and puts forward some ideas about task grouping. Based on this idea, this paper also suggests dividing the system into two parts: the user management module based on the browser/server mode and the collaborative work module based on the P2P mode. The former mainly addresses task decomposition and helps the nodes and tasks find each other, and the latter focuses on the transmission strategy and the conflict management strategy. The design not only takes full advantage of the P2P structure, but also relies on the B/S structure to make up the P2P structure. This is a kind of effective way to solve the problems that traditional collaborative design methods are now facing.
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