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A File Sharing Method Based on P2P Small World Model

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Abstract: This study proposes a method that separates the resource discovery process and resource sharing process from the implementation. We define two private protocols PIEP and PDEP under IPv6 environment. These two protocols can serve the process of the resource discovery and the resource sharing process. The PIEP uses small-world model to find resource information, while the PDEP has a smaller protocol header, so as to achieve the purpose of improving the network utilization.

Key words: IPv6, P2P, Proprietary Protocol, Small-world model, PIEP, PDEP

INTRODUCTION

The file exchange becomes easier after the computer network development, especially the internet development. In the computer network research field, Peer-to-Peer P2P network technology and IPv6 technology are two hot research topics. A lot of works have been done in the IPv6 P2P research field. An adaptive peer collaboration strategy to reduce cross-ISP traffic without additional equipment and backup mechanisms is proposed (Hsu *et al*., 2010), which gives decreased equipment cost. Internal peers can collaborate indirectly. In their peer collaboration strategy, a peer chooses most of its neighbors from the internal ISP and only a few external ISPs to reduce transfer of cross-ISP by biased neighbor selection. In order to solve the problems that physical topology and logical network does not match so as to inefficient search in distributed hash table at present, a hierarchy distributed route structure based on Ipv6 address in peer to peer systems is proposed (Yu *et al*., 2008). A P2P file sharing system (FSP2P) by using Java network programming is designed and realized (Zhao *et al*., 2009). An adapter was contained in FSP2P. By using the adapter, FSP2P not only can be arrayed to pure IPv4 or IPv6 network, but also can be arrayed to IPv4/IPv6 coexistent network. So, it realized transparent connect between IPv4 and IPv6 in P2P file sharing system. The M6P2P design and architecture, the principle and performance is described (Lin *et al*., 2007). The results show that M6P2P can provide good performance but reduce network loads dramatically. Multicast technology of IPv6 and P2P is presented, the route algorithm of free pastry is analyzed, class Epoch I net Socket Address about the management of source route node address is mainly improved, the use of dual stack technology in the system of Fedora Core 6 is introduced, then the Multicast application of P2P with IPv6 environment is designed and implemented (Wu and Yang, 2008). The characteristics and advantages of P2P are analyzed and then the state of the art on research and application in detail is presented (Chen *et al*., 2002). The IPv6 hierarchical structure is applied to make an overlay network congruent to physical network, cluster to decrease churn of the network due to frequent joining is introduced, leaving of the peers to take into account the heterogeneity of peers chooses peers with great capability to take more responsibility in routing and successful resource lookup history to improve routing efficiency is adopted (Cao and Dong, 2008).

Current research achieved a number of effective results in peer to peer network traffic control, P2P network routing, P2P system framework and the implement of P2P model based on IPv6 multicast frame, but there are still some problems. One of the problems is that P2P control information field is too longer. In the Bit Torrent protocol, for example, the size of the head of the protocol is up to 96 bytes (including Tracker and SHA1 checksum), the length is up to 150 bytes after the Ethernet header, IP header and the TCP header is added, while the Ethernet maximum transmission cell value is 1500 bytes. This also means that in each frame transmission process, the control information is 10% and the remaining 90% of the data is the user really needs. The longer control information field increases, the strong the network resource discovery capacity of P2P software is, but also the P2P software for

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network bandwidth requirements also increases. This study presents a resource discovery process and resource exchange process separation idea. It also designs resource discovery algorithm, resource exchange algorithm and the corresponding network protocol. Those can be used to solve the problem that P2P software is of the high bandwidth consumption and low network utilization.

RESOURCE DISCOVERY ALGORITHM

The resource discovery is the process which finds available resources in the peer to peer network. Generally, the resource discovery process can carry out before downloading the resources, so the users can understand which resources can be obtained in current peer to peer network and thus the users are able to determine which resources are interested and should be downloaded.

Small world model: Good network topology is the base of network management (Yang *et al*., 2007) There are some models transmitting information according to a certain way in certain network topology. Small-world model is one of them. The small world model can be used both mobile nodes (Wu *et al*., 2008). The topology calculation can also be used in unorganized P2P systems routing process (Zhou *et al*., 2004). It can also search for files (Feng *et al*., 2006). Small-world model proposed by the American psychologist Stenley Milgram, has been applied in many fields. Especially in the scientific research of computer networks, research and develop of small-world model has played a significant role in promoting.

In the small world model, in human societies worldwide, if everyone sends a message M to 6 friends, then the message M can be delivered to everyone in the world, the whole world will know the news M. In other words, an average of every six people in the friendships, you can pass any two people in the world to build a relationship. This phenomenon is called the small world phenomenon. The application of a mathematical model of small-world phenomenon is known as the small-world model.

Small world phenomenon proves the following two facts:

- The friendship is widespread
- The friendship can be found

From the second facts: In the P2P network, using only local node information, you can search to find effective node with other nodes friendships. This fact provides a theoretical support on distributed resources and resource retrieval.

PIEP protocol format: The PIEP is English acronym of "Peer to Peer Information Exchange Protocol" and can be translated as "peer information exchange agreements." The PIEP protocol is mainly used for control information exchange IPv6-based network resource sharing technology program.

PIEP protocol format is composed by 5 fields, shown in Fig. 1.

Resource discovery algorithm:In this system, we use small-world model to find the friendships. First, the system sets the maximum number Friend_Number of friends for each node. Then, each node establish the friendship with other nodes (the maximum friend node number is Friend_Number and the number of friends can be less than Friend_Number). The friendship established method of new node which is inserted into the P2P network is different from the method of the node which leaves the P2P network.

The friendship established method of new node (denote as NewNode) inserted into the P2P network is as follows:

- The NewNode tests the state of peer network server (central node). If the NewNode cannot connect to the server, they think the P2P network does not exist and the NewNode cannot be added to P2P network, so the program ends and returns
- The NewNode sends the establish friendship request to the server
- The Server sends the node table to the NewNode node, the node table recodes all the nodes which the friend number does not reach to Friend_Number
- If the friend number of NewNode node is up to Friend_Num, then the friendships established successful codes are returns. Otherwise the process continues
- Select a node that the friend number is less than Friend_Number in the node table. The node can be returned by the server and be sent to a friend to establish relationships request. If the NewNode receives a friend relationship response, return to Step 4. If a response can be received, friendships cannot be built or target node response is timeout, then proceed to Step 6
- If the node table returned by the server returns and records all the nodes which the friend number less than Firend_Number is not empty, return to Step 4, otherwise, proceed to Step 7
- Send a friend relationship is not fully established packets to the server

Type	Length	Name	Owner no.	Owner list

Fig. 1: PIEP protocol format

The friend node removes method of node (denoted as Node) from the P2P network is as follows:

- Send a friendship damage packet to the server
- The server returns the node table which contains all the nodes which friend number less than Friend_Number
- If the friend number of node Node is Friend_Num, then return a friend relationship created successfully code to server. Otherwise continue
- Select a node with the friend number less than Friend_Number in the node table by the server and send a friend relationships request. If a friend relationship building response is received, return to step 3. If a response can be received, friendships cannot be built or target node response is timeout, then proceed to step 5
- If the node table by the server returns and records all the nodes which the friend number less than Firend_Number is not empty, return to Step 3. Otherwise, proceed to step 6
- Send packets with a friend relationship not fully established to the server

DATA EXCHANGE ALGORITHM

Resource segmentation: Before the resources transmission, every node in the P2P network need divide the resources into a lot of segmentation. All the segmentation blocks are transferred by the computer network, the size of distributed shared resources can be completed.

In order to achieve the highest rate in different physical networks, different resource divide ways are applied in different network. Overall, the resource block length and transport protocol header length should be equal to the sum of the physical network MTU (Maximum Transmission Unit, Maximum Transmission Unit) value. Let block length is L, the transport protocol header length sum to C, then the block length should be in accordance with the following formula:

$$L = MTU-C$$

PDEP protocol format: The follow Fig. 2 shows the PDEP protocol format.

Resource transfer algorithm: We use PDEP protocol to data transmission. Through PDEP protocol, user can establish download relationships between the resource owners and the downloader. The download process by PDEP is divided into two phases: download relationship establish phase and resource data download phase. The download relationship establishing phase is responsible for recognizing if resource owners can connect and resource owners have the interesting data. Resource data download phase is responsible for resource divide and the resource segmentation transfers.

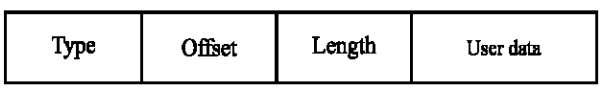

Fig. 2: PDEP protocol format

The algorithm of two phases is as follows:

- Download relationship establish phase

The resource owner:

- The downloader establishes a download relationship between the resource downloader and the resource owner. First, the resource downloader sends resource request packets to the resource owner. One of the following cases occurs:

Case 1: The resource downloader receives the ready packets from the resource owner

In this case, the owner can provide the resource and go to the resource data download phase.

Case 2: Time out

In this case, the resource downloader cannot establish the download relationship between the resource owners.

If the resource downloader receives the ready packets from the resource owner, it indicates that the resource owner can provide the resource data. The next work confirms the resource name and size. The downloader sends a packet to complete this work. After the downloader sends the packets, one of the following cases occurs:

Case 1: The downloader receives the NAME_OK packet. In this case, the owner has this resource and can provide to download and go to the resource data download phase

Case 2: The downloader receives the NAME_ERR packets

In this case, the owner does not have this shared resource and the downloader cannot download this resource data.

The resource owner:

- The resource owner listens at UDP port 75893. If the owner receives the request packets from the

downloader and the state of the owner is ready, then the owner sends a ready packet to the sender and updates the downloader list

If the owner receives the resource name packets, the owner then checks whether the required resource in the shared data list, if the required data in the shared data list, then the NAME_OK packets to the downloader are returned, otherwise the NAME_ERR packets are returned.

- Resource data download phase

In the resource data download phase, the downloader algorithm is as follow:

- The downloader calculates the resource data segmentation size according the number of resource providers
- The downloader calculates whether the download process completed. If the download process completed, send a COMPLETE packet to the owner and the algorithm ends
- The downloader sends a data required packet GET_DATA to the owner. In the GET_DATA packet, the offset and the length value is provided to the resource owner
- If the owner returns a DATA_OK packet, the downloader receives all the data and saves the data on the disk, return to step 2
- If the owner returns a DATA_ERR packet, the downloader deletes all the received data and resends this data block, returns to step 2

EXPERIMENTAL RESULT

Experimental environment: The experiment runs on 6 computers with Intel core i5-3470 3.20GHz CPU, 4GB RAM and Fedora Core 6 operating system. All the computers are connected by a router and all the computers are transferred by the IPv6 address.

Five resource data sets used in the experiment are shown in Table 1.

Experimental result and analyses: For the same resource file, file download time is a measure of the speed. In the experiment, we use download time to measure the advantage of our method.

First, we compare our method with traditional client/server method. In our experiment environment, we use four resource owner and a resource downloader in P2P network and we use one resource server and a resource downloader in the c/s network. The experiment result is shown in Table 2.

Table 1: Experimental data

Resource name	Resource size
test 1.mp3	5357164
test 2.mp3	10374108
test 3.avi	37806080
test 4.avi	83283264
test 5.rmvb	272577098

Table 2: Experiment result

Resource name	Resource size (Byte)	Time in c/s network	Time in P2P network
test 1.mp3	5357164	6234	1969
test 2.mp3	10374108	11812	3500
test 3.avi	37806080	43312	12469
test 4.avi	83283264	95485	27891
test 5.rmvb	272577098	305922	95047

Table 3: Experiment result

Resource name	Resource size (Byte)	No. of owner	Download time (ms)
test 1.mp3	5357164	2	3172
		3	2278
		4	1969
test 2.mp3	10374108	2	6015
		3	4703
		4	3500
test 3.avi	37806080	2	22421
		3	16297
		4	12469
test 4.avi	83283264	2	49547
		3	35875
		4	27891
test 5.rmvb	272577098	2	161875
		3	118891
		4	95047

Table 2 shows that the download time cost in the P2P network is less than the download time cost in the c/s network.

Second, we test our method feature in the experiment. We use the PIEP protocol and PDEP protocol to share five experiment data, the result shows in Table 3.

From the experimental results, the resource sharing system by use of P2P technology can enhance the speed, which is more cases more significant in the resource owners. The experimental results can also show that the use of P2P technology in the resource sharing system makes resources process there no restrictions on the size of the resource file. The resource file that is smaller has good sharing capabilities, while the larger resource file also has good sharing capabilities.

The Fig. 3 shows the download time cost of test 1 mp 3 (5.3MB) with different number resource owners.

From the above Fig. 3, we can see that the download time significantly reduced with the number of resource owner increasing for the same resource. In four resource owners, the download time in the P2P network is shorter 4.26 seconds than in the traditional c/s network mode and the resource download time is 31.58% of traditional c/s network.

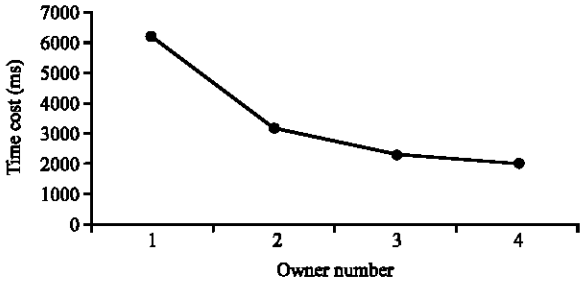

Fig. 3: Download time of different owner number. Test 1.mp3 download time

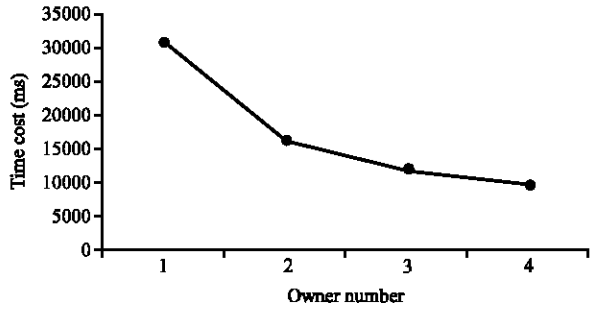

Fig. 4: Download time of different owner number. Test 5.rmvb download time

The Fig. 4 shows that the download time cost of test5.rmvb (272.5MB) has different number resource owners.

From the above chart, we can see that the download time significantly reduced with the number of resource owner increasing for the same resource. In four resource owners, the download time in the P2P network is shorter 3 min and 51 seconds than in the traditional c/s network mode and the resource download time is 31.06% of traditional c/s network.

CONCLUSION

This study first discusses the effect of P2P technology to improve resource sharing capabilities, then introduces relevant theoretical research status of this topic, discusses the current existence of IPv6-based P2P technology with the high bandwidth consumption and low network utilization. This study proposed a method to separate the resource discovery process and the resource transferring process in the IPv6 environment. The experiment result shows that our method is efficient. The next step can be studied in multiple segments across IPv6 peer protocol routing capabilities.

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