http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 11 (10): 1400-1408, 2012
ISSN 1812-5638 / DOI: 10.3923/itj.2012.1400.1408

Research and Improvement of Unstructured P2P Super-Peer Topology and Search Technique

[1,2]Xue-long Wang, [1]Jing Zhang and [2]Huai-zhou Yang
[1]School of Computer Science and Engineering, Xi'an University of Technology, Xi'an 710048, China
[2]School of Computer Science, Xi'an Shiyou University, Xi'an, 710065, China

Abstract: The study analyzed the current popular unstructured super-peer topology and the search technique. In order to avoid the high expense of topology construction, the huge cost of topology repair and the low efficiency of search, a kind of novel construction method of orderly layered super-peer topology guided by the safety peer (OLST) is presented and the search function is realized in this study. After the leaf peers being transferred and layered, the new coming peer will be joined by an assigned safety super-peer. An idea of among friends with similar interests is used to improve the search efficiency of the topology. The experimental results indicate that the method can effectively balance the super-peer load and significantly decrease the construction and repair cost of the topology. Furthermore, the search efficiency is also increased.

Key words: Unstructured peer-to-peer topology, super peer, topology construction, search technique, interest cluster

INTRODUCTION

In recent years, the studies and applications of P2P are popular (Guo *et al*., 2007; Hoong and Matsuo, 2008; Wang and Sun, 2009; Jiang *et al*., 2009; Peng and Zheng, 2010; Ye *et al*., 2011; Wang *et al*., 2011) which have made a great development. In many definitions and implementations of P2P, the equality role of peers is one of the main features. However, it was found that the peer has the difference of "strong node" and the "weak node" in P2P networks through the measurement of existing system (Saroiu *et al*., 2002). According to the difference between the peers, a good way is to make the high ability peers as super-peer that take more important function in the system and then a super-peer P2P network is constructed. The network is usually the two layers topology. According to the super-peer layer whether to support the DHT mechanism, the topology is divided into unstructured super-peer topology and structured super-peer topology. Depend on the need of the application in the future, the study focused on analyzing and studying the unstructured super-peer P2P topology construction and the search technique.

The analysis of unstructured super-peer topology: In the existing unstructured super-peer topology, KaZaA (Liang *et al*., 2004), eMule (http://www.emule. org.cn) and Gnutella0.6 (http://rfc-gnutella.sourceforge.net/src/rfc-0_6-draft.html) are the typical applications. KaZaA, for example, is based on the FastTrack protocol and it is two layers super-peer topology. According to the hardware capability, all nodes are divided into super peers and ordinary peers. In the system, super-peer levels is the core and the super peers store the resources metadata of the file name, file size, the content hash value and so on of the ordinary peers. The super peer set up metadata index library for the ordinary peers and agent the ordinary peers to search the resources. In these protocols, the introduction of super-peers could not only reduce the number of peers in the routing but also make full use of the heterogeneous of peers and reduce the bottleneck problem of the ordinary peer in network. SG-1 (Montresor, 2004) is a robust protocol for building super-peer overlay topology. The protocol is capable to deal with a continuous flow of peers joining and leaving the system. However, the mechanism is based on the well-known gossip paradigm, with peers exchanging information with randomly selected peers and rearranging the topology. So the performance and security need to be further improved. FENG Guo-Fu etc., Feng Guo-Fu *et al*. (2007) proposed a topology optimization strategy based on the weight of peer content being accessed which is based on analyzing the relationship between the peer contents, the peer connectivity degree and the search success ratio. And it improves the success ratio. However, the topology construction costs and peer load balance were not considered.

Corresponding Author: Xue-long Wang, School of Computer Science and Engineering, Xi'an University of Technology, Xi'an 710048, China

Following are their common characteristics. (1) Peers are assigned the role of super peer or ordinary peer in system. In the topology, only super peers participate in system routing, resources releasing and searching. Super peers are the core in system. (2) The hierarchical topology is organized. According to the ability of peers, they are assigned to join the super-peer layer or the leaf peer layer and the super-peer layer can also be differentiated. (3) The construction method is different with the single-layer topology's. In the super-peer model, when the ordinary peers are dropping, system don't need to modify the route table and just delete it from the index library of the super peer. However, when the super peer is dropping, the system is not only need to modify neighbor super peer in the route table but also need to deal with the indexes of the leaf peers. When the load of super peer is unbalanced, it is necessary that the super peer is divided, merged and adjusted. (4) Peers have the complex relationships. Because, in the super-peer model, peers are divided into super peers and ordinary peers and ordinary peers are divided into candidate super peers and ordinary peers. Therefore, the relationships between the peers contain super peer and ordinary peer, super peer and candidate super peer, super peer and super peer, etc.

Compared with the single topology, the unstructured super-peer topology has three advantages. (1) Routing performance and scalable are improved. Because, in the super-peer model, only super peers are participating in the routing and super peers are few than ordinary peers, the performance of topology is superior to the single topology. (2) The stability of system is strengthened. In the super-peer topology, because the super peers are more stable than ordinary peers and the ordinary peers only need to be deleted from the super-peer local index library when it dropping, the system is more stable. (3) The total load of system is decreased and the search time is shortened. Because the ordinary peers are not participating in routing and the number of routing peers in search are few than the total number of peers in the super peer model, the message numbers are less than the single-layer topology's. Moreover, during the process of search, super peers match resource in local index and the messages are not be broadcasted in inner group, so the message number of the system is also being reduced.

For the unstructured super-peer topology, the random construction method based on the rumor is easy to bring three problems. (1) The construction cost of topology is increased because the role of peers is changed between the super peers and the ordinary peers are detected at random. (2) System is lack of some methods of being supervised and evaluated because the peers determine the role by oneself. (3) The search efficiency of topology is ignored and the system performance is affected, etc.

The search analysis of unstructured super-peer topology: The search technique of unstructured super-peer topology is based on the search technique of single layer topology and the improvement. Flooding, Modified-BFS (Kalogeraki *et al*., 2002), Iterative Deepening (Yang and Garcia-Molina, 2002), Expanding Ring (Yang and Garcia-Molina, 2002) and Random Walk (Gkantsidis *et al*., 2004) are common techniques. These are referred to as blind search technique. In flooding, search request messages are transferred to the direct neighbor peers and the neighbor peers are also forward messages to their whole neighbor peers until the hops is zero. The others, for example Modified-BFS and so on, are the improvement of the flooding. In the process of messages forwarding, these search techniques have a common feature which is peers of the next jump are chosen at random, not using any existing information of the resources or peers in network.

The Local Index (Yang and Garcia-Molina, 2002), BFS (Yang and Garcia-Molina, 2002), Routing Index (Crespo and Garcia-Molina, 2002), Adaptive Probability (Tsoumakos and Roussopoulos, 2003) , Bloom Filter Index (Yi-Ming *et al*., 2008) and content based searching (Renuga and Sadasivam, 2009) are all search techniques of information retrieval which are the improvement of blind search technique. Depending on the resource position, the peer ability or the successful search information and so on, a route index of neighbors is building before searching. According to the route index, search messages were transferred to some good peers. Therefore, compared with the blind search technique, the techniques of information retrieval can quickly find the target resources and effectively reduce the search cost and improve the search accuracy.

According to the above mentioned, the techniques of blind search and information retrieval have three problems. (1) The efficiency is low, especially to the flooding method. (2) Compared with the single topology, the scalability of topology is still affected although few messages between super-peers are spread in network. (3) The results and performance of search are uncertain.

Aimed at the problems of topology construction, topology repair and search, a kind of novel construction technique of orderly guided by the safety peer and layered super-peer topology (OLST) is presented in the following. It makes the trusted peer be chosen as the super peer and improves the system reliability. The Experiments show that the method can decrease the construction cost, reduce the search message quantity and keep the system load balance.

THE ORDERLY GUIDED AND LAYERED SUPER-PEER TOPOLOGY

The description of model:

- **Definition 1:** A peer is defined as a five tuple (I, L, C, D, X), where: I, L, C, D and X represent the identification, the layer, the capacity, the degree and the resource list of peer, respectively. If L of the peer is 1, the peer lies the super-peer layer. If L of the peer is 0, the peer lies the leaf -peer layer
- **Definition 2:** The route table of peers is defined as a three tuple (SR, CR, PR), where:
    - SR represents the route table of super peers. Each neighbor super peer takes up an entry and is checked regularly. All entries form the upper super-peer network
    - CR represents the route table of leaf peers. It contains the address and capacity of leaf peers. Super peers rank the leaf peers according to their online time and the ability of hardware and chose the optimal leaf peer as the candidate super peer. Super peers send the information of the candidate super peer to the leaf peers and regularly send CR to the candidate super peer
    - PR represents the route table of father super peer which is directly connected by the leaf peers and the candidate super peers. Leaf peers send query messages to their father peer through PR and regularly update their mate data in the PR of father super-peer
- **Definition 3:** The OLST is defined as <G, E>, where:
    - G is a set of peers and E is a set of edges
    - $G = \{g_1, g_2, g_3, \ldots, g_n\}$. $g_i = \{p_1, p_2, \ldots, p_n\}$. $\exists p_i \in g_i$ and $L_p = 1$, $i \in \{1, 2, \ldots, n\}$
    - If $p \in g_i$ and $q \in g_k$ $j, k \in \{1, 2, \ldots, n\}$, then $<p, q> \in E$

Let the size of a network be 100000 and the capacity of super peer be 50 and the average load of peers be 80%, according to the model and the least rule of super peer in reference "Design a Superpeer Network" (Beverly Yang and Garcia-Molina, 2003), then there are 2500 super peers in the OLST.

The implementation of orderly guideed and layered mechanism: In order to avoid the super peer being blindly chosen and effectively control the super-peer load and safety, the super peers are chosen by the safety super peer guiding and the new peer is orderly joined and the topology is being layered in the method. The implementation of method is described in Fig. 1. A super peer is assigned as the guide peer at first. A high capacity and long online peer is selected by the guide peer from the reliable candidate peers as new super peer. The new super peer is in charge of accepting some leaf peers of the guide super peer according to its capacity and it make friends with the guide peer instead of the relationship of father and leaf. Topology is layered when the degree is larger than the capacity of the guide peer. Instead of the super peer being chosen based on the rumor method, the new super peer is chosen from the leaf peers by the guide super peer when it is overload. Some other leaves of the guide super peer are transferred to the new super peer. The degree of the guide super peer is decreased and it can accept the new coming peer. According to the above mentioned, the super peer being chosen and the topology construction are under the control, so the construction cost of OLST is low.

The time complexity of the algorithm is mainly caused by leaf peers being transferred. Let the shift leaf peers be n, then the algorithm is executed by the n cycles and the time complexity is O (n). Because the size of n is constraint by hardware capacity of peer and the better leaf peer is always chosen as the candidate super peer, so the time complexity is low.

The strategy of peer joining and dropping: When the OLST is constructed, it not only needs the algorithm of Figure 1 but also needs the strategy of dealing with the joining and dropping of peers in topology.

Joining a peer: In constructing the OLST, a peer joins the system according to the idea of orderly guided and the super peer is adjusted and the leaf peers are separated. First of all, a well-known register server as super peer is started. Then, the register recommends a specified super peer to guide the new coming peer to join P2P networks. Before the new coming peer joins the network, the assigned super peer checks whether it has free ability. If the degree is smaller than the capacity, then the peer is joined. Otherwise, some leaf peers are separated firstly and then the super peer joins the new peer to the leaf peer list. The example is described in the following:

Let A be a super peer which is the well-known register server in OLST at the beginning. And let CA, CE and CF be 3, 2 and 2, respectively. If there is a new peer X, X wants to join the OLST which is consisted by the A, B, C, D and G peers. The specific process is illustrated in Fig. 2:

```
Input: Some peers and a well-known super peer
Output: A double layer super-peer p2p network
Begin
 Set the peer number of Network as m;
 Set a new peer and a super peer as p1 and p2;
 Set the capacity of p2 as Cp2;
 Set the degree of p2 as Dp2;
 Set the friend super peer of p2 as friends SP List;
   Where friendsSPList is not NULL
       Select a super peer from friendsSPList of p2 to guide to join new peer;
      Calculate the level of super peer;
      If Cp2-Dp2>0 then
 AddNode(p1,p2); //add the peer p1 to p2.
 Return;
       End if
       Caculate the ChildNodeIndex TreeMap map of p2;
       If map is not Empty then
 Select the long-online and power leaf tp of the p2;
 Calculate the capacity and the Degree of tp as Ctp and Dtp;
         If Ctp>Dtp then
 Calculate the number for leaving peer of p2.
 Set Ltp as 1.
              Transform selected peers to tp.
           Else then
 Select another good leaf tp of p2;
 Iterative call the function;
          End if
           Update tp and p2;// Update the degree, capacity, routine table of the p2 and tp.
           End if
           End where
 End
```

Fig. 1: The implementation of orderly guided and layered mechanism

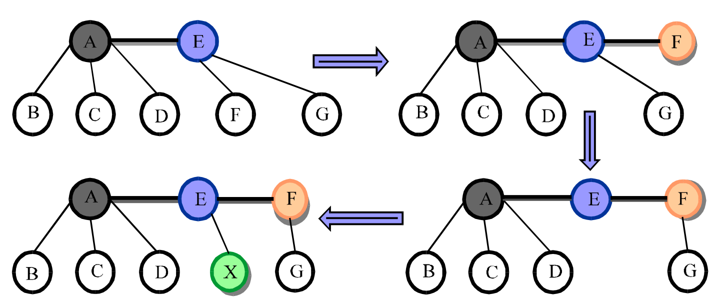

Fig. 2: The joining process of a new peer

- **Step 1:** The peer E which is a super peer in friends list {A, E}, is assigned by the peer A to guide the peer X and E will be responsible for joining X into the OLST
- **Step 2:** Super-peer E checks itself capacity. If it has the spare capacity, then X is joined and the index or route information of E and X is updated. If the D_E is larger than C_E, then the step 3 is carried out
- **Step 3:** Super-peer E chooses a new candidate super-peer F from its leaf peers depending on the online time and the capacity of peers. The super peers update their route information each other
- **Step 4:** If F has free capacity, then there are:

$$\left[\frac{D_E C_F}{(C_E + C_F)}\right]$$

leaf peers of E being transferred to F. Now, the peer E has free capacity to join X. Because the formula result is 1, G is transferred to peer F
- **Step 5:** Peer X join into the leaf peer list of the E and the information of PR is updated

Peer dropping: P2P systems are natural highly dynamic which has a great influence on the P2P network with frequent peers joining and dropping. When a peer drops the OLST network, some modifications need to be done in order to maintain the correctness of the network. During the interaction between the peers, some dropping or failure peers are discovered. If it is a leaf peer, it is removed from the parent. If it is a super peer, a candidate super peer is orderly chosen from PR firstly and then all of the leaf peers are moved to the new super peer and the route table of the related super peers is updated. When the capacity of candidate super peer is beyond, another leaf peer is orderly chosen as candidate super peer and the previous operation is repeated until the leaf peers are transferred. Finally, all the route table of the associated peer is updated.

THE IMPLEMENTATION AND IMPROVEMENT OF THE SEARCH

The implementation of search: The OLST is a super peer topology. The search techniques are similar to the Gnutella0.6's (http://rfc-gnutella.sourceforge.net/src/rfc-0_6-draft.html). The random walk search algorithm of the OLST is implemented in Fig. 3. Super peers are the agency of the leaf peers and store the index of leaf peers and forward the search messages. Super peers connect together form a top super-peer network. When a leaf peer searches some resources, it is first that looking for the index of the super peer. If the resource was found, two peers connect directly and download resources. If it is not found, the super peer put the search messages to other super peers connected with each other at random until the resources are found.

The search algorithm of OLST is comprised of three cycles. The steps of the first cycle depend on the number of resources m and the steps of the second cycle depend on the number n of leaf peers and the steps of the third cycle depend on the resources k of leaf peers. The three cycles nested each other, so the time complexity of algorithm is O (n^3).

The improvement based on interest cluster: By the experiments, we find that the efficiency of random walk search can be improved in OLST based on the idea of interest clustering (Schlosser *et al*., 2003; Si and Song, 2008; Modarresi *et al*., 2008; Jin-Xiao *et al*., 2010). We modified the OLST topology under the same construction cost and the search efficiency is improved. The specific measures are the following. (1) Peers add a tuple E. E represents a vector $\{e_1,e_2,\ldots,e_n\}$,where e_i represents an interest and n is the size of interest domain. (2) When chose a candidate super peer, it should not only have free capacity but also it has similar interest. Let E_A be a vector $\{e_{A1}\ e_{A2},\ldots,\ e_{An}\}$ and E_B be a vector $\{e_{B1},\ e_{B2},\ldots,\ e_{Bn}\}$ and then the formula 1 is the calculation of the similarity Sim

```
Input:    Resources being searched and the OLST
Output:    Found or Not found and some statistical information
Begin
  Set the search resource number as m;
  For i=1 to m
     Set a search resource as sr.
     Select a super-peer sp1 from the super-peer list.
     Calculate map for the children peer index of sp1.
     If map is not empty then
    Calculate n for the children number of sp1.
    For j=1 to n
       Select the jth child peer cpj of sp1.
       Calculate k for the resource numbers of cpj..
       For x=1 to k
          Search sr in the kth resource of cpj.
          If found then Return. End if
      Next
     //if not found sr in the children peer of sp1
    Select another super-peer sp2 from the super-peer list of sp1.
    Find the resource sr in sp2. //call the find(resource,node) function to do.
    If not found sr then
       Select other neighbor super peer and iteration call the find function.
   End if
  Next
 Next
 Output statistics result.
End
```

Fig. 3: The implementation of search algorithm

(A,B) of peer A and peer B. The value represents the similarity between the peers. (3) When a peer joins the network, the super peer of maximum similar interests are chosen in all recommended super-peers and then the above mentioned is followed for peers joining in the network:

$$\mathrm{Sim}(A,B)=\frac{\sum_{i=1}^{n} e_{Ai}\times e_{Bi}}{\sqrt{\left(\sum_{i=1}^{n} e_{Ai}^{2}\right)\left(\sum_{i=1}^{n} e_{Bi}^{2}\right)}}$$

After the improvement, peers connect to the super peer with the same interests and the super peers become the cluster center of the same interest group. In search, peers can directly locate in the other peers of the same group. Moreover, the peers can quickly reach other interest groups through the connections between the friend super peers. So the search efficiency of OLST is improved.

The experiments and analysis: All experiments in this study are completed on a PC that the configuration is Intel (R) Core (TM) 2 Quad CPU@2.83, 2.82 MHz, 2 GB RAM and Microsoft Windows Server 2003 operating system. Using the cycle-based engine of the PeerSim (http://peersim.sourceforge.net/) which is an open source project and the Java language, we simulate the topology construction and search of the OLST and the similar Gnutalle0.6 (for short Gnu). The load balance, the construction cost, the repair cost and the search performance are being analyzed and compared. The specific parameters of the simulation are shown in Table 1.

The load balance analysis of the OLST: The load rate of super peer is represented by the value of the super-peer degree being divided by the super-peer capacity. The change of network load is shown in Fig. 4. Along with the scale of network increasing, the different degree distributions also show the growing trend in OLST. It shows the reasonable growth of the network. Figure 4 represents the change of super-peer load with the scale of network. The load rate of super peers keeps on between 30 and 40% in different network scale which can effectively avoid the problem of the "hot spots" in OLST.

The analysis of the construction cost and the repair cost: The construction cost and the repair cost of topology are represented by the number of messages. In network, there are three types of common messages. One is the request messages which are produced by one request peer, when it joins into the network. Two is the response messages which are the responses of the requests. The third is the move messages which are produced by leaf peers being transferred. Because the request message is corresponding to the response message, we only take into account the request messages and the move messages in simulation. Therefore, the construction cost and the repair cost represent the sum of the request messages and the move messages.

Figure 5 represents the variation of construction cost with the changing of the network scale. Because the OLST uses the method of the orderly guided and layered, the construction cost is obviously less than the construction cost of Gnu which is constructed by the flooding technique. For example, when the network scale is 70000 peers, the construction cost of the OLST is 228000 but the construction cost of the Gnu is 413552.

Table 1: Simulation parameters and settings

Parameter type	Parameter	Value	Default
Network	Size	1×10^4-7×10^4	10000
	α of the power-law	1.8	-
	Peer capacity	20-80	20
	Failure ratio of peers	0.3-0.8	0.3
	Size of router table	20	-
Resource	Resource number	5-20	10
Simulation	Hops	5-30	20
	Search number	100-2500	1000

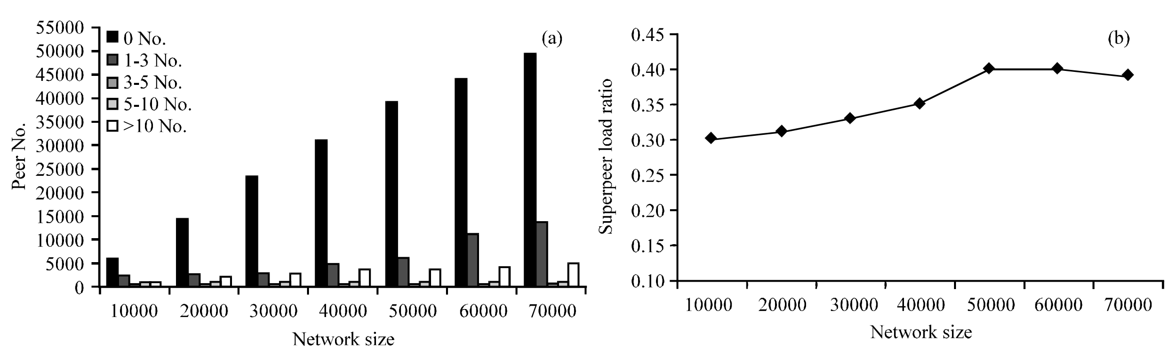

Fig. 4(a-b): (a) Peer load vs. network size (b)The super-peer load ratio vs. network size

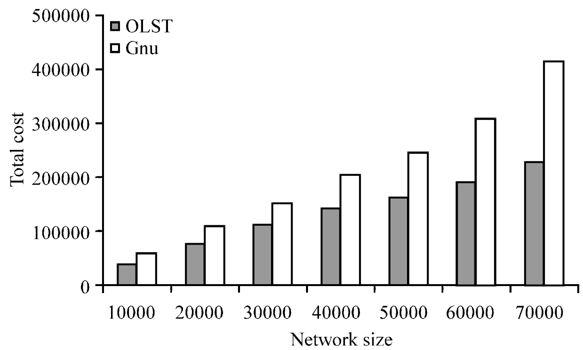

Fig. 5: The construction cost of OLST and Gnu

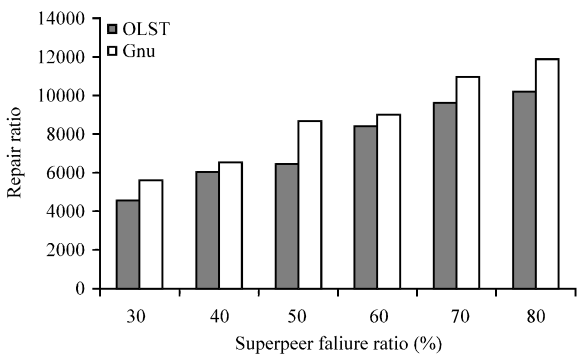

Fig. 6: The repair cost of OLST and Gnu

Figure 6 represents the variation of repair cost of the OLST and the Gnu when the failure rate is changed from 0.3-0.8. The repair cost is increasing, when the failure rate is increasing. When the super peer is dropping, the candidate super peer was specially assigned in the OLST, so the repair cost of the OLST is less than the repair cost of the Gnu. For example, when the failure rate is 0.5, the repair cost of the OLST is 5694 but the Gnu's is 8662. According to Fig. 5 and 6, it is shown that the construction cost and the repair cost of the OLST is decreased obviously.

The analysis of search efficiency: In the experiments, all kinds of search are using the random walk method and each request is sent from a random peer. Aimed at the OLST, xqOLST and Gnu network, the search success rate, the search stability and the search average hops are analyzed and compared. The xqOLST represents the improvement of the OLST using the interest cluster:

The search stability of the three networks: The stability is represented by the success rate of search which should be consistent, when the resource numbers are changing and the other parameters of network remain unchanged.

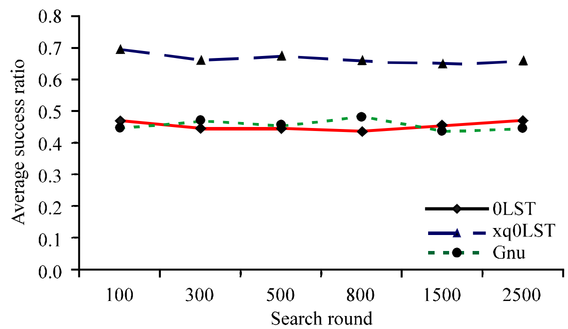

Fig. 7: The search stability

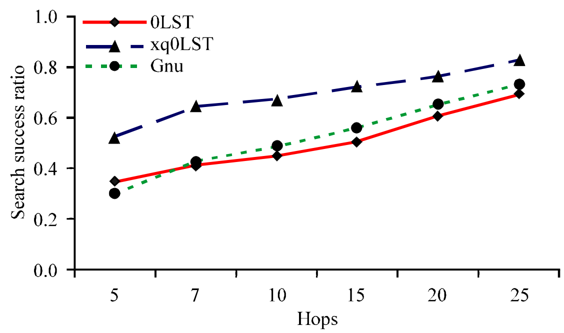

Fig. 8: The search success rate vs. hops

In simulation, the success rate of the three topologies keeps balance when the search cycle changes from 100-2500 times. The search stability is shown in Fig. 7. The performance of OLST and Gnu is similar because their topologies are similar. However, the construction cost and the repair cost of them are different. Because of using the interest cluster in xqOLST, the search efficiency is obviously improved. The deviation of their success rate is 0.04. They have a good stability of the search.

The search success ratio of the three networks: The success rate is represented by the value of the number of successful requests divided by the total requests in network. The variation of the successful search ratio is shown in Fig. 8. The success search ratio of OLST and Gnu is similar because the topologies are similar. However, because the peers is clustered using the common interests, the success ratio of search of the xqOLST is superior to the others. At the tenth hop, for example, the success ratio of OLST, Gnu and xqOLST is 0.45, 0. 49 and 0. 67, respectively.

The search average hops of the three networks: The average hops are the value of the successful search hops divided by the search times. The variation of the search

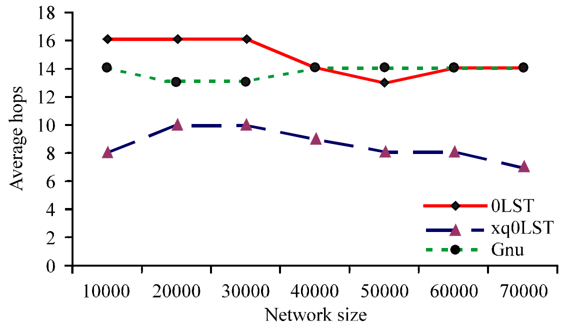

Fig. 9: Average hops vs. network size

average hops is shown in Fig. 9. Their average hops keep balance with the network scale increasing. The average length of the OLST and the Gnu keep on between 12 and 16 hops. However, the average hops of the xqOLST keeps on between 6 and 8 hops. The average hops are smaller and then the search network traffics are less and the network scalability is better. Therefore, the scalability of the xqOLST is better than the others.

These experiments show that compared with the unstructured super-peer topology network, for example the Gnutella0.6 and SG-1, the method proposed in this study also has the node load balance and network load balance. However, at the same network scale, the network construction costs are significantly reduced and when the node failure rate is same, the network repair costs are decreased. Meanwhile, the system has a good query stability and scalability as same as the other but the query efficiency and system reliability are improved.

CONCLUSIONS

Based on the analysis of the unstructured super-peer topology and search, the study describes the characteristics and the problems of the P2P topology. And a novel construction method of orderly guided and layered P2P super-peer topology (called OLST) is presented and the search function is realized. The method can effectively controls the construction of topology and the construction cost and the repair cost are obviously decreased. The simulations show that the OLST is superior to the super-peer topology constructed by broadcast method and the construction cost and the repair cost are low. Moreover, the search efficiency of the OLST was improved. The xqOLST can effectively improve the search success ratio and reduce the search range. In next step, we will focus on the study of the actual application and security on the OLST, such as the trust model and the identity authentication and so on.

ACKNOWLEDGEMENTS

This research was partially sponsored by the National High-Tech Research and Development Plan of China under Grant No.2007AA010305, the Shaanxi Province Science and Technology Research and Development Plan of China under Grant No.2011K06-33 and the Xi'an City Industrial Research Project of China under Grant No. CXY1129-6.

REFERENCES

Beverly Yang, B. and H. Garcia-Molina, 2003. Design a superpeer network The Proceedings of the 19th International Conference on Data Engineering March 5-8, 2003 Dept. of Comput. Sci., Stanford Univ., CA, USA 49-60.

Crespo, H. and Garcia-Molina, 2002. Routing indices for peer-to-peer systems. Technical report, Computer Science Department, Stanford University.

Feng Guo-Fu, Zhang Jin-Cheng, Jiang Yu-Quan, 2007. Optimization of overlay topology for unstructured peer-to-peer. J. Software, 12: 2819-2829.

Gkantsidis, C., M. Mihail and A. Saberi, 2004. Random walks in peer-to-peer networks. 23rd Annual Joint Conference of the IEEE Computer and Communications Societies March 7-11, 2004 Coll. of Comput., Georgia Inst. of Technol., Atlanta, GA, USA.

Guo, Y., J. Xi, D. Tang and X. Li, 2007. A transaction description model and properties for P2P computing. Inform. Technol. J., 6: 509-517.

Hoong, P.K. and H. Matsuo, 2008. Push-pull two-layer super-peer based P2P live media streaming. J. Applied Sci., 8: 585-593.

Jiang, X., S. Jiang and T. Peng, 2009. A multi-channel multimedia content distribution strategy using multiple description coding. Inform. Technol. J., 8: 1084-1093.

Jin-Xiao, F., C. Gui-Hai and X. Jun-Yuan, 2010. P2P super-peer topology construction based on hierarchical quadrant space Chin. J. Com., 33: 987-1003.

Kalogeraki, V., D. Gunopulos, D. Zeinalipour-Yazti, 2002. A local search mechanism for peer-to-peer networks. The ACM 11th Int'l Conf. Information and Knowledge Management (CIKM' 02) November 4-9, 2002 McLean, Virgina, USA.

Liang, J., R. Kumar and K.W. Ross, 2004. Understanding KaZaA.http://www.ntbaba.com/wenku/10/UnderstandingKaZaA.pdf

Modarresi, A., A. Mamat, H. Ibrahim and N. Mustapha, 2008. Measuring the performance of peer-to-peer systems with social networks characteristics J. Applied Sci., 8: 3895-3902.

Montresor, A., 2004. A robust protocol for building superpeer overlay topologies. Proceedings of the 4th International Conference on Peer-to-Peer Computing (P2P`04) August 25-27, 2004 IEEE Press, Washington 202-209.

Peng, T. and Q. Zheng, 2010. Resource occupation of peer-to-peer multicasting. Inform. Technol. J., 9: 438-445.

Renuga, R. and S. Sadasivam, 2009. Data discovery in grid using content based searching technique. Inform. Technol. J., 8: 71-76.

Saroiu, S., P.K. Gummadi, S.D. Gribble, 2002. A measurement study of peer-to-peer file sharing systems. Proceedings of the Multimedia Computing and Networking, January, 2002, San Jose, USA., pp: 1-15.

Schlosser, M.T., T.E. Conide and S.D. Kamvar, 2003. Simulating a file-sharing P2P network. Technical Report, Stanford InfoLab, http://ilpubs.stanford.edu:8090/589/

Si, W.U. and O. Song, 2008. Improved search algorithms based on interests correlation in P2P network Com. Eng., 6: 102-107.

Tsoumakos, N. and Roussopoulos, 2003. Adaptive probabilistic search (APS) for peer-to-peer networks. Technical Report, CS-TR-4451.

Wang, C., R. Wang, H. Chen and Y. Huang, 2011. Study of automated trust negotiation mechanism based on cache sequence game in P2P environment. Inf. Technol. J., 10: 2014-2023.

Wang, X. and X. Sun, 2009. Fair blind signature based authentication for super peer P2P network. Inform. Technol. J., 8: 887-894.

Yang, B. and H. Garcia-Molina, 2002. Improving search in peer-to-peer networks. Proceeding of the 22nd International Conference on Distributed Computer System, July 2-5, IEEE Xplore, London, pp: 5-14.

Ye, L., H. Zhang and Q. Dai, 2011. Identifying P2P application with DHT behaviors. Inform. Technol. J., 10: 565-572.

Yi-Ming, Z., L.U. Xi-Cheng, Z. Qian-Bing and L.I. Dong-Sheng, 2008. An efficient search algorithm for large-scale P2P systems. J. Software, 19: 1473-1480.