Improved Resource Search Strategy Using Random Walk Based on Node Reputation for Unstructured Mobile P2P Network

Junwei Ge, Hongxia Shi, Yiqiu Fang
School of Communication and Information Engineering, Chongqing University of Posts and Telecommunications, Chongqing 400065, China
E-mail: shihongxia2013@163.com

***Abstract*—With the development of wireless communication technologies and mobile devices, the P2P network technology has the conditions to be used in wireless environments. Resource search is to discover requested object in mobile P2P network (mobile peer-to-peer network), which is one of the core issues of mobile P2P application. Aiming at low efficiency of resource search in mobile P2P network, a search strategy using improved random walk based on node reputation (SSRWBR) is proposed in the paper. By introducing a reputation mechanism based on the random walk model, the neighbor ultrapeer with maximum reputation value is selected to forward the query walker during the search process, which can solve the problem of low resource efficient searching.**

Keywords—mobile peer-to-peer network(MP2P), resource search, random walk, node reputation, success rate

I. INTRODUCTION

P2P network is also called peer-to-peer network. Compared with the C/S (Client/Server) network, there is not the central node in the whole network. The network topological structure is distributed. Nodes in the network acts the resource gainer and providers at the same time, and all nodes have equal status, which has double functions as a client and a server. P2P network technology has the scalability, robustness, lower maintenance cost characteristic of deployment, which represents the characteristics of Internet, such as: equality, open, free.

To date, with the increasing development of wireless communication technology and mobile device, it provides the possibility to access wireless network services at any time, any place for the every user[1]. Due to the distributed and self-organizing feature, P2P has been widely used in many fields and greatly improves the utilization of network information and computing resource. Introducing P2P into wireless network generates mobile P2P network, as shown in Figure 1. Mobile devices which can exchange message directly through peer provide support for the mobile P2P application. Also, it can apply in the military, emergency and temporary occasions. Thus, many mobile P2P applications emerge. Resource search is one of the key technologies in mobile P2P network. So it is necessary to make further study on resource search strategy for the mobile P2P network.

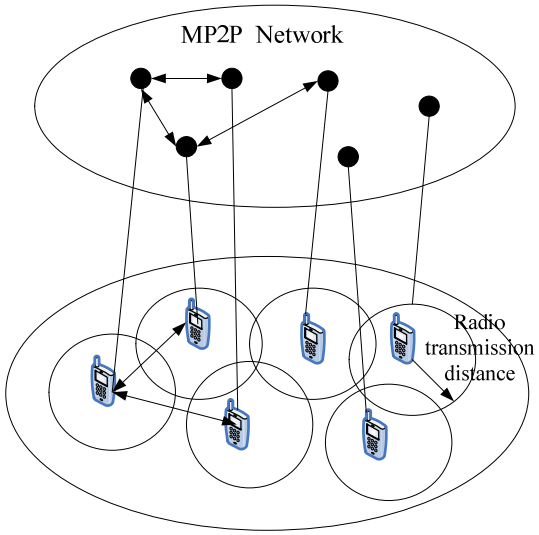

Figure 1. MP2P Network

Resources search strategy which is core topic in mobile P2P application means a node to discover object files from other nodes in the network. However, it faces new challenges because of the characteristics in mobile P2P network. Mobile P2P networks exists different characteristics from fixed P2P network system. They have three reasons: (1) Node with limited capacity. Compared with a node in fixed P2P network, the mobile devices as a node in mobile environment have followed features: smaller size, limited processing and storage capacity, limited bandwidth, shorter communication range, limited battery capacity and so on; (2)Network topology with higher dynamic. Node in mobile P2P network usually is phone, PDA and so on. They have stronger mobility because their position in the network changes frequently. Furthermore, nodes join or exit network arbitrarily, resulting in the change of network topology randomly. (3)Uncertain connection. The uncertain connection is determined by the characteristics of the unreliable wireless network environment. Compared with wired networks, the bandwidth is limited and the link is

vulnerable to the influence of transmission medium. The electromagnetic waves acts the transmission medium, which is interfered and shielded facing obstacle, bad weather and complicated electromagnetic environment.

To further improve the search efficiency of MP2P network, we propose a novel search strategy using improved random walk based on node reputation (SSRWBR). In search process, we introduce node reputation. When multiple walker random walk forwards query walker to neighbor ultrapeer, the reputation value of node is considered in SSRWBR. The neighbor node with maximum reputation value is selected to forward query walker. Selecting neighbor ultrapeer which is forwarded through node reputation table reduces the searching response time , and improve the success rate of resource search.

Rest of the paper is organized as follows: Section II discusses the related works on resource search of the MP2P network. Section III explores system model. Section IV presents the proposed search strategy. In section V concludes with a critical summery.

II. RELATED WORKS

There are two types search resource strategy in mobile P2P network: structured network search and unstructured network search. The strategy of structured search based on DHT is a distributed. DHT buffers the resource information of many other nodes, and whose network topology has structural feature. So it also can be called structured P2P network. CAN[2]、Chord[3]、Pastry[4] are typical structured P2P system. There are research to improve a typical DHT system, makes it suitable for mobile environment. Literature [5] proposed an improved super-node-based CAN search algorithm, and is called M-CAN. To improve resource discovery efficiency, reduce network bandwidth and computing resources that mobile devices occupied, it uses registration and packet mechanism to replace the CAN file transfer and caching mechanism respectively.

Flooding search algorithm, random walk algorithm are typical unstructured P2P system. Information broadcasting search algorithm which based on the flood search belongs to the fully distributed search strategy, which does not exist the single point failure problem, and there is no strict requirement for maintain the connection between participating nodes. The ultrapeer just records the location information of neighbor nodes, and forwards a search request to a neighbor ultrapeer or creates a backward response to source ultrapeer according to the search request when there is a search request arrives. As its shortcomings, it needs to find a wide range of network for object file, which consumes large amounts of network bandwidth and increases network load dramatically. Gnutella is typical information broadcasting P2P system, which based on the flooding search. Literature [6] proposed a method that searches neighbor node as a way to start the server, and using cross-layer design approach to modify Gnutella to adapt the wireless environment. In the basic random walk resource searching algorithm, the source node randomly selects a node as the next hop from its neighbor nodes and forwards the query request message. The query request message contains the TTL(Time to live)field in walker and TTL minus 1 per logical hop. The termination time is finished until the target resource is found or TTL is 0.

The unstructured network topology is incompact. Node resource storage is independent of node location. This network topology supports fuzzy search. But it is necessary to search in large scary network, even in whole network for searching the resource that we want. It brings the massive searching redundancy message and occupies a large amount of bandwidth. Thus, the network load is increased, the delay of searching is becoming long, and the search speed is slow. This causes the poor performance of network topology.

This research topic is the resource search algorithm in unstructured MP2P network, which is over Mobile Ad Hoc networks. The literature[7] proposed cache optimization technique, ultrapeer selection scheme to make communication more efficient between peers and ultrapeer, and multiple walkers random walk approach with controlled replication. To eliminate message duplication in the search process while maintaining the smallest possible response time, our article introduces node reputation on the selection of next neiborgh ultrapeer to forward.

III. SYSTEM MODEL

The search model of this paper has the two parts, including the multiple walker random walk search model and reputation mechanism model, as shown in Figure 2. In SSRWBR, each

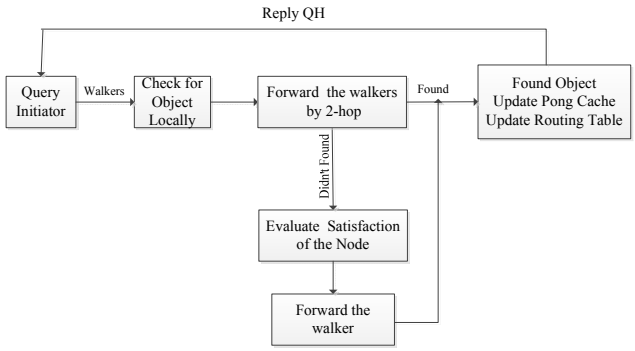

Figure 2. Resource search strategy model of SSSWBR

ultrapeer in the network needs to maintain three tables: pong cache table, routing table, node reputation table. The reputation table contains each neighbor node reputation value. When the node receives query requests, ultrapeer finds the local cache firstly. If object file is not found, the ultrpeer initiates *m* query walkers to search target resource by 2-hop. The neighbor ultrapeer with maximum reputation value is selected as relay node to forward query walker. After a period of time, node reputation table is updated according to node historical interaction satisfaction.

A. Random walk model

Random walk is a search algorithm applied in the unstructured mobile P2P network. We choose Gnutella to operate in dynamic wireless environment via the introduction of leaf and ultrapeer nodes in Gnutella V0.6[8] for this study.

The nodes that have power processing capacity and long online time are deemed to ultrapeer, while the rest in the network is regarded as peer. The pong cache table and routing table is maintained by ultrapeer. Furthermore, pong cache table stores the resource index of the 1-hop ultrapeer, and routing table is utilized to memory routing information of other nodes. As shown in Figure 3. resource indexing and routing information

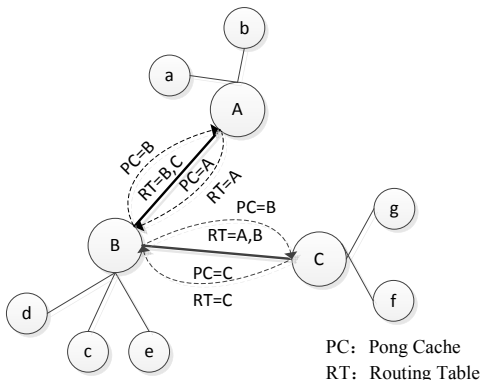

Figure 3. Exchange of pong cache and routing table

of neighbor node A, C is stored in the node B, and pong cache and routing table are updated after successful searching.

Due to the frequent ultrapeer's join and exit, Mobile P2P network has high dynamic characteristic. Therefore, the message should be exchanged periodically between ultrapeers to update neighbor node list to keep connection active. Within given time frame, if reply message is not received, the ultrapeer is replaced randomly by the new neighbor ultrapeer.

In random walk model, source ultrapeer initiates m query walkers to march around unstructured mobile P2P network. Each query walker skips directly connected neighbor ultrapeer, forwarding the query walker toward the 2-hop neighbor. When ultrapeer with required file or ultrapeer with pong cache of required file is found, it replies QH message to query initiator according to the routing table information. As shown in Figure 4 blow, the ultrapeer 0 is query initiator; ultrapeer 10 contains

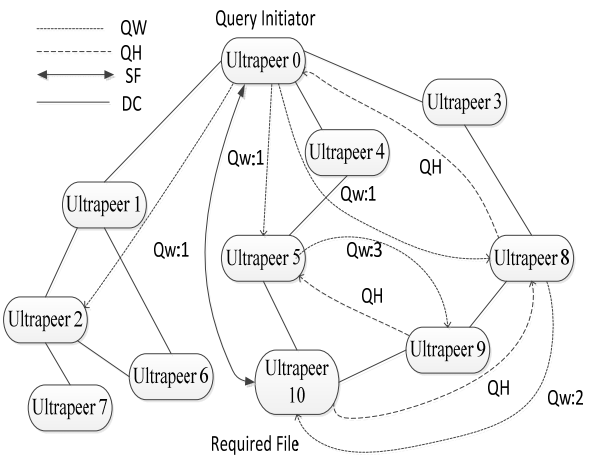

Figure 4. Multiple query walker forwarding

required file; ultrapeer 9 contains the pong cache of required file. QW denotes Forward Query Walker; QH denotes Query Hit; SF is Sharing File; and DC is Direct Connection. The ultrapeer 0 initiates query walkers and forwards to neighbor ultrapeer 2, 5, 8, which is 2-hop away originating ultrapeer. If object is not found, query walker is forwarded to ultrapeer 9 and ultrapeer 10 by 2-hop way. So ultrapeer 9 with pong cache and ultrapeer 10 with object resource reply QH message to ultrapeer 0 after receiving query walker. Then node 0 is informed that found required file in ultrapeer 10 through firstly received QH message.

B. Reputation Mode

The reputation denotes satisfaction degree of the node for the historical interactive information[9]. Node reputation is divided into direct and recommendation reputation[10]. As shown in Figure 5, we assume that there are *L* intermediate

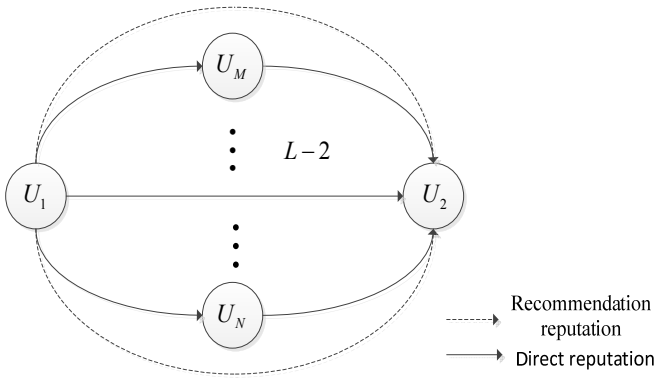

Figure 5. Node reputation relationship model

ultrapeer between ultrapeer 1 and ultrapeer 2, for example node *M* and *N*. And U1, U2, UM, UN denote ultrapeer 1, ultrapeer 2, ultrapeer *M*, ultrapeer *N* respectively; solid line is the direct reputation; dotted line represents the indirect reputation.

The direct reputation value is defined through evaluating interactive behavior in the historical information interaction. We obtains direct reputation value by the way of ultrapeer voting, as shown in Eq.(1),

$$DR_A(B) = \frac{1}{n} \times \sum_n Score_A(B) \tag{1}$$

In the above formula, *n* denotes the number of information interaction in given time (0,t), $Score_A(B)$ denotes the score of ultrapeer B evaluating ultrapeer A for one time interaction behavior.

Recommendation reputation means no interactive information directly between two ultrapeers, and the relation is established according to intermediate nodes recommendation. Therefore, recommendation reputation value can be obtained through calculating the direct reputation value of intermediate ultrapeers by weighting. As shown reputation model in figure 5, recommendation reputation value is obtained in Eq.(2),

$$RR_A(B)=\mu_1\left(DR_A(M)\times DR_M(B)\right)+\underbrace{\cdots}_{L-2}+\mu_L\left(DR_A(N)\times DR_N(B)\right) \quad (2)$$

where $DR_A(M)$, $DR_M(B)$, $DR_A(N)$, $DR_N(B)$ denote the direct reputation value of recommendation path AM, MB, AN, NB; μ_1, μ_L denote the weight of recommendation path, which satisfy the constraint relationship $\mu_1+\mu_2+,\ldots,+\mu_L=1$. Therefore, we obtain the total reputation value, as shown in Eq.(3),

$$TR(A,B)=\lambda\times DR_A(B)+(1-\lambda)\times RR_A(B) \quad (3)$$

where λ denotes the weight of direct reputation. Each ultrapeer maintains a reputation table to provide a forwarding basis for 2-hop neighbor ultrapeer.

IV. SSRWBR SEARCH STRATEGY

This research is limited to consider only *m* ultrapeers and ignore the total number of leaf peers in the network. Based on the aforementioned theoretical model, this section will discuss the resource query process in detail. It divided into three steps.

Step1. Initiating query walkers. The query walker contains the source node ID, the resource description and PTL (peer to leave) and so on. *PTL* field is defined in walkers to eliminate unsuccessful queries and prevent infinite query. The ultrapeer checks target resource locally. If required file is found, it will reply the QH(query hit) message to source ultrapeer immediately. If there is not found, it will check the PTL and go to Step2.

Step2. Executing our forwarding strategy. The ultrapeer checks whether the PTL is 0. If PTL is 0, it will reply "failed search message" towards source ultrapeer immediately, and the query is terminated. If PTL didn't minus to 0, it will view the reputation table and choose a neighbor ultrapeer with maximum reputation value to forward query walker.

Step3. Updating the index messages. *PTL* value decreases at each logical hop. Finishing one query, the ultrapeer updates pong cache and routing table. After a certain time, ultrapeer evaluates the satisfaction to update the reputation table. As the same way, ultrapeer process other queries. The termination time for query walkers occurs when either the object is resolve called successful termination or the *PTL* reaches to zero or whole network is searched and still fail to find an object called unsuccessful termination.

V. CONCLUSION

Resource searching is core topic in unstructured mobile P2P network. Typical mobile P2P protocols largely relied on flooding, random walks and selective forwarding to route queries and discover objects file, which incurs a relatively high search time due to remarkable network traffic, multiple copies and duplication of query messages. To solve this problem, we propose a system model, which chooses a 2-hop jumping walkers towards node reputation based selected ultrapeers to manage peer mobility for resource searching. This protocol is designed for searching in dynamic environment, where co-operation between peers is important and network traffic needs to be minimized.

REFERENCES

[1] Ou ZH, Song MN, Zhan XS, Song JD, "Key techniques for mobile peer-to-peer networks," Journal of Software,2008,19(2):404−418.

[2] Ratnasamy S, Francis P, Handley M, et al, A scalable content-addressable network. ACM, 2001.

[3] Stoica I, Morris R, Liben-Nowell D, et al, "Chord: a scalable peer-to-peer lookup protocol for internet applications," Networking, IEEE/ACM Transactions on, 2003, 11(1): 17-32.

[4] Rowstron A, Druschel P. , "Pastry: Scalable, decentralized object location, and routing for large-scale peer-to-peer systems," Middleware 2001. Springer Berlin Heidelberg, 2001: 329-350.

[5] Peng G, Li S, Jin H, et al, "M-CAN: a lookup protocol for mobile peer-to-peer environment," Parallel Architectures, Algorithms and Networks, 2004. Proceedings. 7th International Symposium on. IEEE, 2004: 544-549.

[6] Conti M, Gregori E, Turi G, "A cross-layer optimization of gnutella for mobile ad hoc networks," Proceedings of the 6th ACM international symposium on Mobile ad hoc networking and computing, ACM, 2005: 343-354.

[7] B. Shah and K. Kim, "Towards enhanced searching architecture for unstructured Peer-to-Peer over mobile ad Hoc networks," Wireless Pers Communication, DOI 10.1007/s11277-013-1560-7, Dec. 2013.

[8] Gnutella Protocol Development. http://rfc-gnutella.sourceforge. net/ src/ rfc-0_6-draft.html. Accessed July 22, 2012

[9] HAWA M, AHMAD L, KHALAF L, "On enhancing reputation management using Peer-to-Peer interaction history," Peer-to-Peer Networking and Applications, 2013.6(1):101-113

[10] Huan-lin Liu, Gao-xiang Chen, Yong Chen, Qian-bin Chen, "A trust-based P2P resource search method integrating with Q-learning for future Internet," Peer-to-Peer Networking and Applications.

[11] ZHOU Jinyang, Yang Shoubao, Guo Leitao, et al, "Resource Discovery Algorithm Based on Reputation-Aware in Peer-to-Peer Networks," Mini-Micro Systems,2006,27(10):1798-1802.