Journal of Theoretical and Applied Information Technology
15th November 2012. Vol. 45 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

APPLICATIONS OF LOCAL-RANGE NETWORK THEORY IN DESIGNED P2P ROUTING ALGORITHM

[1]YUNXIA PEI, [2]GUANGCHUN FU

[1]Department of Math and Computer Science, Zhengzhou University of light Industry, Zhengzhou 450002, Henan, China

[2]School of Mechanical and Electrical, Henan Institute of Science and Technology, XinXiang 453003, Henan, China

ABSTRACT

Peer-to-peer file sharing has a great prospect, Peer-to-peer search problems have become the academic focus of one of the research questions. Already distributed P2P systems for the lack of caching mechanism unorganized navigation capacity of the lack of global routing algorithm, is a disorderly search this end, this paper proposes the modified key clustering algorithm, the routing space the NT and ST layers of orderly search, from global perspective. Scalable Key clustering algorithm, we learn from the Local-range field research, inserted into the connector quick Link remote node in the routing table with a certain probability, to shorten the average path length. Preliminary simulation results have shown that the introduction of modified key clustering algorithm has better search capacity and scalability than original algorithm.

Keywords: *Routing, Modified Key Clustering, Local-Range, Peer-to-Peer Network*

1. INTRODUCTION

Peer-to-Peer network system in the file-sharing and information search more and more applications. P2P system is constituted by a group of equal status to the node between nodes can communicate directly, without first the three parties are involved. Compared with a centralized structure, P2P structure has innate advantages in scalability, real-time, reliability and load balancing.

The search algorithm is the primary factor to decide P2P system performance. Napster [1] uses a centralized search web search engine, rather than a true distributed search, but facing centralized search with the amount of information overload, denial of service attacks (Denial of Service, DoS) are difficult to solve the problem.

Purely distributed search algorithm on the index structure can be divided into two categories: strict structure index and freedom structure index [2]. Typical algorithms belonging to the strict structure index Tapestry [3], Pastry [4], CAN [5] and Chord [6], through strict control of the network topology and file storage location to retrieve results, at the same time ensure that the search for the number of steps in the range of O(logN) (N is the total number of nodes), scalability search algorithms too many restrictions on the node, and the need for strict control of the network topology and file storage location, so they are more suitable for running on the enterprise network.

Free structure index given node full STonomy only index records based on search history on adaptation, so the wide application prospects. Typical representative of such methods Gnutella [7], Freenet [8] were the basic search principle breadth-first search (BFS) and depth-first search (DFS), these two algorithms robustness, but operating efficiency is very low, the width of the diffusion type first search result in the number of messages is increasing exponentially, retrospective depth first search result in time-consuming too long local index algorithm [9] statistical information of a neighbor, according to the neighborhood information to choose the right direction to search, in order to reduce the amount of messages but it is, after all, only the use of local information for heuristic search, the lack of global perspective, search performance improvement is still very limited., designed the key clustering algorithm to improve search performance, by gradual adjustment of the node index records according to certain centers clustering on the physical network layer routing layer that has a global perspective in order to reduce the average path length, we use local-range research to determine clustering to probabilistic clustering with randomness, introduced in the navigation table point far distance

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

node fast connection (shortcut), in theory, improve the expectations of the average path length of the algorithm is O(log2N).

The paper is organized as follows: Section 2 gives a description of the search problem; Section 3 Key Clustering algorithm and improved algorithm; Section 4 by simulation test the performance of the algorithm; Finally, in Section 5 to conclusions.

2. DESCRIPTION OF THE PROBLEM

P2P search algorithms discussed in this paper will be limited in the context of unorganized system, the meaning of the "unorganized":

1) Network topology free;

2) System requirements node without caching node only needs to store data locally, it is not necessary for the system to share the storage tasks.

2.1 Distributed Search

Distributed search algorithm, the search command send an object along the nodes are connected to pass. Select messages according to certain strategies neighbors receive the message, first retrieve the local data matching will match the success message back along the original path transmitted to the initial node; choose the neighbor continues to spread message search depth is controlled by TTL (Time-to-live) counter message before every send (forward), TTL minus 1, when the TTL reduced to 0:00, before the message stops sending a P2P search of the final result is the sum of the results of all the search branch.

2.2 Evaluation

Comprehensive previous studies [9-10], we use the following criteria to evaluate the search algorithm performance:

1) Search success rate

$$SearchSuccessRate = \frac{NumberofSearchSuccess}{NumberofSearch}$$

2) Average path length

Average path length is the average length of the search path. The average path length is to determine the direct factor of the latency time.

3) Number of message

The number of messages that will affect the network load and node computing resources, under the premise of ensuring the success rate of the search, to reduce the number of messages is an effective means to improve search performance.

3. KEY CLUSTERING ALGORITHM AND LOCAL-RANGE APPLICATIONS

3.1 Key Clustering Algorithm

A. Index Constitutes

Key clustering algorithm index using the distributed hash table (DHT) [11], using the hash function to map the file attributes (such as file name, or descriptive keywords) as the key. Key in ascending order, and end-to-end to form the annular space, key space is located in the superstructure physical node layer , searchable search, query mapping for the key definition of key distance between the shortest distance on the annular key space for them, i.e. $D(a,b) = \mathrm{Min}\{|a\text{-}b|, |M\text{-}a\text{-}b|\}$, wherein M is the total number of the key space.

Each node has assigned the central server in cluster center, node search performance update routing tables content cluster toward the center of each node is evenly distributed in the key space in order to ensure timely query hot spots to track changes over time, the central server will, according to a recent query distribution allocated for the node center, the index balanced to ensure that the entire system.

For k in the routing table (shown in Table 1) need to maintain a length of the nodes in the local routing table is divided into the navigation table (NT) and the subject table (ST) in two parts, the length respectively, of K_H and K_A (K_H+K_A=K). The ST table recorded node ID, and on behalf of its file feature key, NT, table records the node ID and its center. from a functional point of view, the ST levels the key numerical sequence rearrange documented from a global perspective, NT level stated at the node center value order node, and the formation of the ordered routing layer system is running, the two respectively to be updated in accordance with certain clustering strategy.

Table 1: Routing Table of KC Algorithm

Node 003 center = 4340		
	key	Node ID
NT	4216	218
	4855	82
	……	
ST	4217	264
	4209	318
	4532	403
	……	

B. Search Process

Journal of Theoretical and Applied Information Technology
15th November 2012. Vol. 45 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Retrieve local file search, query matching along the same route back to send the results to update the routing tables of the nodes on the path at the same time; Otherwise, the in ST table lookup query, if match, before you send the message to the appropriate node; ST table there is no matching node from the NT table to find the closest to the query node (i.e., the center with the query close), and sends the query to the node.

C. Routing Table Update Policy

Set the search path of length L, search command for q, from the starting node to the destination node, followed by: n_1, n_2, ..., of n_L, therefore they can be considered and q as a node on the path involved in the search for q of the correlation is large, therefore, after the search is successful, the KC algorithm interested node's routing table update operation.

NT table update policy:

For n_x (x=1,2,⋯⋯,L-2), the NT table update:

① Order by waiting to join the new record key_{Ins}=center(n_{L-1}), center(n_{L-1}) is the n_{L-1} of the cluster centers, corresponding the recorded as <key_{Ins},n_{L-1}> chose n_{L-1} learning objectives, n_{L-1} as the last path messaging for search success made the most important contribution;

② If NT table under new record <key_{Ins}, n_{L-1}>, the end of the update; perform ③ The NT table full;

③ Be deleted the old record key_{Del} to record from center(n_x) n_x NT table. key_{Del}=Max {D(key_x, center(n_x))}, key_x is n_x a NT table in any one of the records;

④ If D(key_{Ins}, center(n_x))<D(key_{Del}, center(n_x)), with the new records replace the old records; Otherwise, do not do any changes.

ST table update policy:

For n_x (x=1,2,⋯⋯,L-1), the ST table update:

① n_L at search q, n_L file must contain q, the node will record the information on the path. Waiting to join the new record key_{Ins}=q, the corresponding record for <key_{Ins}, n_L>;

② If ST table under added new record <key_{Ins},n_{L-1}>, the end of the update; ST table is full, perform step ③;

③ The pending delete the old record key_{Del} as the largest key from the center(nx), i.e.: of key_{Del}=Max {D(key_x, center(n_x))}, key_x of the ST table in any one record in n_x of the ST table ;

④ If D(key_{Ins}, center(n_x))<D(key_{Del}, center(n_x)), with the new records replace the old records; Otherwise, do not do any changes.

We hope that after enough times updated, NT and key in the ST can effectively clustering in the center.

D. Algorithm theory

Intuitively speaking, Key clustering idea is to allow each node to perform their duties, the division of labor on the entire key space. Carry out their duties by ST, ST responsible for managing key space within a period of regional key (non-mandatory), regional midpoint is the clustering of center. ST table can be rebuilt in the original node level top global order management; NT the record node center FAQ center on behalf of the functions of the node, the node is able to understand each other's functions through the NT, poly the NT after class can ST level to establish orderly routing layer.

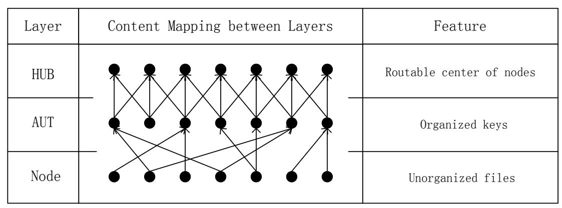

Figure 1: Content Mapping between Layers of KC Algorithm

In Figure 1, the different levels of the representative node of the longitudinal, transverse represent different nodes. KC algorithm created in the layer of the original node ST layer and NT layer node arranged in accordance with the numerical order of the key. Node layer pointing arrow represents the original of the ST layer the arrow key information node description of the local file ST layer how to reset the layer point NT layer ST layer the description node functions of the center information in the NT layer rearrangement.

Without any pattern node layer, the distribution of key search can not be achieved at that level; ST layer reschedule key distribution key to belong node clustering, each node in charge of the ST center around within a certain range of the key; ST layer, NT layer to establish the routing layer, is responsible for establishing the links between nodes, each node the NT in charge of this node center around a range of other nodes in the center, so that each node can be learned about the neighbor (center adjacent or similar), and thus guarantee that the search can be effectively carried out.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Specifically, in the key space, the search key to increment or decrement direction forward.

ST records of the other nodes in the file key, if the query with a record matching ST distance target node within a whisker; NT ensure that the search in the right direction, and do not have to go to repeat road we can image that the ST storage files (in fact, there are still a step away from the file), NT stored navigation information. the KC algorithm routing table is very similar to the situation on the www, many pages containing both information file (such as: text, images), and contains a pointer to a similar theme to the website link, that is, the web has two characteristics the authority and the center (NT), the routing table was split into ST and NT idea is derived from this table.

The NT with ST has the same cluster centers reasons: to maintain consistent navigation direction and the search target or navigation lost significance mutual the NT with ST relationship is collaborative and indispensable, NT each node linking up to create the search structure, and eventually hit the target to be achieved by ST.

3.2 The application of local-range theory to improve KC algorithm

A. Local-range and its Applications

The famous Stanley Milgram experiment found that pass through an average of six people acquaintances can link any two people in the society, the phenomenon known as the local-range phenomenon. Milgram experiments revealed two discoveries: 1) short-chain effect widespread ; 2) people can find short-chain discovery description: When the network presents a topology, using only local information can find short-chain this discovery provides an opportunity for the distributed information search.

Watt and Strogatz proposed model (WS model) [12] is a commonly used local-range model: N nodes are distributed in the rings, the initial state, each node has a k-th connection, and respectively connected to the recent k points. Then sequentially adjust the connection of each node, a terminal connected to a randomly changing, with probability p, but avoid connected to the node itself.

Hutchison D(i, j) is the shortest distance between the nodes *i* and *j*, the average path distance L calculated as follows:

$$L = \frac{1}{n(n-1)/2}\sum_{1\le i<j\le n} D(i,j)$$

When $p \approx 0$ and $L \sim \frac{n}{2k}$, network topology regularly;

At that time, $0.001 < p < 0.01$, $L \sim \frac{\ln n}{\ln k}$, at node not only connected with the presence of adjacent nodes and distant nodes establish a few shortcut is these shortcut shorten the effective L, the entire network showing the characteristics of local-range.

KC algorithm, node sequentially the numerical order of the center is placed on the annular key space, the search message sequentially transmitted along the ring, the average path length of O(N) This leads to the average path length with the growth of the total number of nodes, proportional growth, search success rate decreases, which seriously affect the usefulness of the KC algorithm.

In order to solve this problem, we learn that the research results of Kleinberg [13], improved KC algorithm. Kleinberg has model is a k-dimensional lattice network, to issue a connection node u to proportional to $[d(u, v)]^{-r}$ is the probability to establish a connection with the v (where v is an arbitrary non-U node; d(u, v) represents the u, v grid distance; r is a constant, called clustering index for the degree of clustering of the control node) In simple terms, a node with neighboring nodes to establish a greater possibility of connection, the possibility of establishing a connection with the remote node is small.

Kleinberg had proved known, for k Dizzy wig network, when and only when r=k, there is a distributed search algorithm, such that the average path length is logN polynomial scale particular, for 1 Dizzy wig network when When r=1, L is the size of the logN polynomial KC linked list belongs to the 1-dimensional grid network, when the connection is established to the probability of the $d(u, v)^{-1}$, the expectations of the average path length $O(\log^2 N)$.

B. Modified Key Clustering Algorithm

Kleinberg-based research on the KC algorithm NT table update policy improvements proposed EKC algorithm (Modified Key Clustering), and the ST table update strategy is still the same algorithm KC.

The EKC algorithm NT tables update strategy is as follows:

As n_x (x=1,2,······,L-2), the NT table update:

① Order waiting added the new record

Journal of Theoretical and Applied Information Technology
15th November 2012. Vol. 45 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

key_{Ins}=center(n_{L-1}), the cluster centers of the center(n_{L-1}) is the n_{L-1}, the corresponding record for <key_{Ins},n_{L-1}>;

② If NT table under new record <key_{Ins},n_{L-1}>, the end of the update; perform ③ The NT table full;

③ Calculation of each record in the NT table delete probability, mind u=center(n_x), the delete key v probability $P(v)=\frac{D(u,v)^{-1}}{\sum_w D(u,w)^{-1}}$, Where w is any KEY NT table according to delete probability randomly select a key to be deleted records, denoted key_{Del};

④ recalculated delete probability key_{Del} and key_{Ins}.

$$P(key_{Del})=\frac{D(u,key_{Del})^{-1}}{D(u,key_{Del})^{-1}+D(u,key_{Ins})^{-1}}$$

$$P(key_{Ins})=\frac{D(u,key_{Ins})^{-1}}{D(u,key_{Del})^{-1}+D(u,key_{Ins})^{-1}}$$

According to delete the probability of randomly determined the deleted object, the NT table to make the appropriate adjustment.

The EKC algorithm has updated NT tables in terms of probabilities, the introduction of a few random shortcuts for NT table.

4. THE SIMULATION RESULTS

4.1 Experimental Set

In the simulation experiment, it is assumed that each node has a uniform distribution of the same number of neighbors, information resources in the system in the simulation, the system consists of n nodes, each node from a capacity of 10,000 key library is randomly selected the key local file characteristics to represent each node is randomly selected the nodes as neighbors each test several simulation, each simulation multiple searches, randomly selected for each search query initiating node randomly selected query. Update search path node routing table after the search is successful the other parameters are described in Table 2.

Table 2: Definition and Value of Symbols

Illustration	Signal	Parameter
Total number of nodes	N	500
Numbers of keys in the pool	KPL	10,000
Number of keys per node	KPN	3
Number of neighbors per node	NPN	3
Size of routing table	RTS	100
Size of NT table	NTS	25
Size of ST table	STS	75
Times of searches	Sear	100,000
Times of simulations	Simu	20
Time to live	TTL	7

4.2 Comparison of Three Algorithms

In order to investigate the performance of the KC and EKC algorithm search, we chose the Local Index object for comparison. Three of the total capacity of the routing table is 100 KC, EKC the NT and ST capacity of 25 and 75.

Table 3: Performance of Three Algorithms

Policy	Success Rate (%)	Average Message Number	Average Path Length
Local Index	21.52	108.17	6.56
Key Clustering	48.87	70.66	5.74
Modified Key Clustering	55.34	50.19	3.61

Table 3 compares the search performance of the three algorithms, the data for the average of 20 times simulation, each test search frequency is 100,000, and other parameters shown in Table II can be seen that the role in the hierarchical clustering, the routing table performance has been significantly improved. The KC and EKC success rate than the Local Index more than doubled, while the average number of messages and the average path length, both significantly less than the Local Index.

Compared and KC, EKC performance further improved due to the presence of a small amount of the EKC NT shortcut to speed up the search process, so that the average number of messages and the average path length reduced by 29.0% and 37.1%, respectively, than the KC, which is the success rate of 13.2% increase.

Figure 2 compares the KC and EKC in a different number of nodes, the average path length variation, in addition to the total number of nodes and TTL, the test parameters set the same as in Table 2, the TTL is taken as from the figure can be more clearly seen, with the node increase in the number of KC curve rising speed much faster EKC curve consistent with the theoretical exponential trend due

Journal of Theoretical and Applied Information Technology
15th November 2012. Vol. 45 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

to the impact of the growth of the number of nodes, EKC better promotion than the KC future work will node the number and the average path length gives more accurate qualitative analysis.

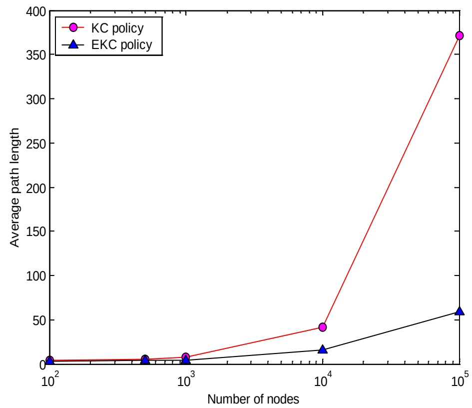

Figure 2: Average Path Length To Different Node Number

4.3 Analysis and Discussion

A. NT Layer Search

From Figure 3, we can see the visual difference of KC search and EKC search, such as a) shown in the KC algorithm NT layer, the distribution of connection rules, sequentially transmitted from A to B through a neighbor message, the path length proportional to D (the center (A), the center (B)); EKC algorithms exist a few random Shortcut can play the role of shorten the path A to B in b), the shortest path length distance from step 3.

Should be noted that, in the search starting stage, NT layer can accurately guidelines search direction, but close enough to the query, the NT layer navigation role will no longer evident, because the routing table (including the ST and NT) of the key at a distance recently with the center is not in the strict sense. example, compared with the node v, and the center with the query node u closer, but can not satisfy the query of the ST can u and v can be, therefore, in the search close enough to the query might jump in the center close to several nodes, which is similar to that traversal search the interested path length has some influence, but overall, NT layer to search for the global navigation capability is valid, tests have verified this point.

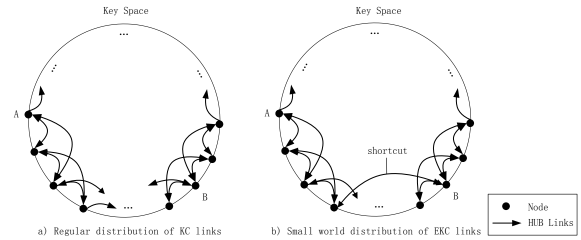

Figure 3: An example of topology in NT layer

B. The NT table and ST table capacity ratio

Fixed the total capacity of the routing table, but the NT table and ST table capacity proportion and there is no limit, from a functional point of view, the two played a role of navigation and management of key, indispensable. NT table size is given in figure 4 relations with the success rate, in addition to the NT, ST capacity, test values with table I. As NT capacity accounted for a larger proportion of the total capacity of the routing table, the success rate curve showed a feature first and then decreased in about0.25, reached the extreme value, the NT capacity at this time 25 ST capacity 75. NT table ratio is too low, the lack of information of the navigation search, the success rate of a serious decline; the NT table proportion is too high, ST table relatively smaller, the management the number of the key is too small, a direct impact on the search success rate.

Currently, the lack of theoretical analysis About NT proportion of the optimization problem only through experimental means to determine the optimal value of the optimization problem is one of the issues for future research, involving factors may include: the total number of nodes, key count, as well as key serial number distribution.

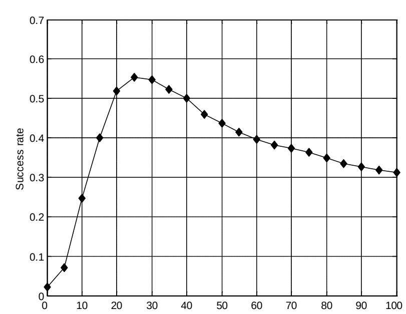

Figure 4: Success Rate Vs. NT Size

C. The Fault Tolerance

Node of freedom exit organizations must consider Figure 4 shows the node exit EKC

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

algorithm success rate, the basis of the success rate of all nodes online, the vertical axis represents the ratio of the current success rate with the benchmark. Tests, to ensure that the resources exist in the system of more than 3 parts meet query, to ensure that the exit part of the node, the search is still possible to find the results, and other parameters set the same as in Table 2.

Figure 5, as the node exit proportion increases, the curve began to decline slowly, when the exit rate = 35%, the success rate is still maintained at more than 80%. Curve was accelerated decline, when the exit rate = 50%, the success rate was only about 10% of the original.

The exit rate, in addition to the exit node of the routing table is no longer play a role, and the work involved in the routing table of the node to the exit node records also fail, Figure 5 illustrates a still effectively surviving minority NT connection guidelines search direction Meanwhile, the clustering of the ST table Refine destination search range, saving the number of message transmission. visible, EKC has good fault tolerance. Contrast, tissue disorder routing table search capability is entirely dependent on the effective recording of the quantity node exit, the blindness of the search will be more prominent, and the success rate is often as exit rate proportional decline.

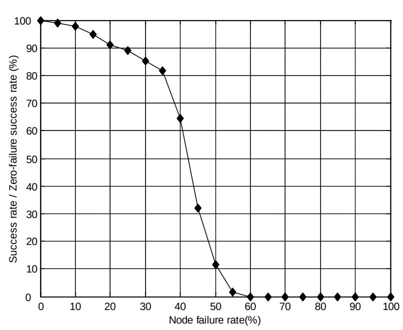

Figure 5: Success Rate Vs. Node Failure Rate

5. CONCLUSIONS

In this paper, a distributed routing algorithm unorganized P2P system search disorderly conduct research, Key clustering algorithm, it will route the spatial the NT and ST two layers, to build a routing table from a global perspective in order to achieve an orderly search in order to improve the expectations of the average path length is equal to O(N) conditions, we draw a local range research in the routing table at a certain probability, inserted into the connection of remote node shortcut connections, in theory, the expectation of the average path length to improve O(log2N), improves the scalability of the algorithm. Preliminary simulation results show that the introduction of the quick Link Key clustering algorithm has good search capability, scalability and fault tolerance. future research questions include: 1) NT table with ST table capacity the ratio issues; 2) in the horizontal chain structure, how to create a vertical hierarchical model; 3) on the hierarchical clustering ST table, so as to further reduce the size of the routing table, improve search efficiency.

REFRENCES:

[1] Bhagwan R, "Automated availability management in large-scale storage systems", [Ph.D. Thesis], San Diego: University of California, 2004.

[2] The Overnet/eDonkey Web site. 2000. http://www.edonkey2000.com

[3] The maze Web site. 2002. http://maze.pku.edu.cn

[4] Tati K, Voelker GM, "On object maintenance in peer-to-peer systems", *Proceeding of the IEEE International Workshop on Peer-to-Peer Systems*, IEEE Conference Publishing Services, March 21-25, 2011, pp. 122-130.

[5] Adya A, Bolosky WJ, Castro M, Cermak G, Chaiken R, Douceur JR, Howell J, Lorch JR, Theimer M, Wattenhofer RP, "FARSITE: Federated, available, and reliable storage for an incompletely trusted environment", *Proceeding of the 10th USENIX Symposim on Operating Systems Design and Implementation*, USENIX Conference Publishing Services, October 4-6, 2011, pp. 320-328.

[6] Kubiatowicz J, Bindel D, Chen Y, Czerwinski S, Eaton P, Geels D, Gummadi R, Rhea S, Weatherspoon H, Weimer W, Wells C, Zhao B, "OceanStore: An architecture for global-scale persistent storage", *Proceeding of the International Conference on Architectural Support for Programming Languages and Operating Systems*, ACM Conference Publishing Services, March 13-17, 2010, pp. 190-201.

[7] Douceur JR, Wattenhofer RP, "Competitive hill-climbing strategies for replica placement in a distributed file system", *Proceeding of the 25th International symposiums on Distributed Computing*, IEEE Conference Publishing Services, September 20-22, 2011, pp. 45-55.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[8] Schwarz TJE, Qin X, Miller EL, "Availability in global peer-to-peer storage systems", *Proceeding of the 6th Workshop on Distributed Data and Structures*, IEEE Conference Publishing Services, July 8-9, 2004, pp. 77-87.

[9] Bhagwan R, Tati K, Cheng YC, Savage S, Voelker GM, "TotalRecall: System support for automated availability management", *Proceeding of the Networked Systems Design and Implementation*, USENIX Conference Publishing Services, March 29-31, 2004, pp. 160-168.

[10] Liu HY. Analysis of resource characteristics and user behavior in P2P file sharing system maze [MS. Thesis]. Beijing: Peking University, 2009.

[11] Weatherspoon H, Kubiatowicz J, "Erasure coding vs. replication: A quantitative comparison", *Proceeding of the 1st International Workshop on Peer-to-Peer Systems*, IEEE Conference Publishing Services, March 7-8, 2010, pp. 50-58.

[12] Lin WK, Chiu DM, Lee YB, "Erasure code replication revisited", *Proceeding of the 4th International Conference on Peer-to-Peer Computing*, IEEE Conference Publishing Services, September 9-11, 2009, pp.131-140.

[13] Rodrigues R, Liskov B, "High availability in DHTs: Erasure coding vs. replication", *Proceeding of the 4th International Workshop on Peer-to-Peer Systems*, IEEE Conference Publishing Services, February 26-27, 2011, pp.70-77.