Query Forwarding with Multi-Mobile Agents for Content Sharing in Peer-to-Peer Network

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***Abstract*—Various researches on query forwarding for content sharing over unstructured Peer-to-Peer network have been carried out. With the methods proposed in the past researches, there exist problems such as mis-recognition of information required for contents' searching due to dynamic change of network such as joining and leaving of peers, and increase of cost for keeping the information up to date, then the methods are not necessarily effective. In this research, we propose a method in which multiple dynamic network agents circulate in the network, always grasp the latest topology of contents sharing network and contents' deployment, propagate the grasped information to each peer, and efficiently transfer queries for contents to be searched. Furthermore, the proposed method is evaluated by using computer simulations, and its effectiveness is shown by the result.**

I. Introduction

In content sharing in Peer-to-Peer (P2P) network, it is necessary for the user to efficiently discover and acquire desired contents, and various mechanisms for content search have been researched so far. In a structured P2P network, it is possible to prepare a structure for transferring queries for content search by using a distributed hash table like such as Chord[1] or CAN[2]. However, in a dynamic network where peers join and leave intermittently, extra operational costs occur. On top of that, because of using a hash function, this kind of system is not suitable for advanced searches such as partially-matching search.

On the other hand, content sharing in unstructured P2P network like Gnutella[3] and Freenet[4] can be executed without being affected by network topology and content deployment, and has an advantage that content searchings with high degree of freedom can be operated. However, there exist problems such as large network load and decrease of search efficiency both caused by increase of queries.

Therefore in this paper, we focus on the unstructured P2P network and propose a method to efficiently transfer queries by making multiple mobile agents circulate around the network, investigate network links and contents deployment information, and propagate those information to each peer.

II. Previous Studies

As related researches of content sharing in unstructured P2P networks, the following papers of [5]-[7] can be listed.

First, in flooding method[5] used in Gnutella, a peer requesting a content forwards a query to an adjacent peer, and if the peers who received the query do not have the content, each query is repeatedly forwarded to the adjacent peer; the number of forwarding is limited within the value of TTL (Time To Live). If there is a peer possessing the content, it is delivered to the requesting peer by tracing the transferring route of the query in reverse.

In the method called Direct Index (DI)[6], each peer holds a table called DI describing the positions of the other peers and their usefulness, and when searching a content, the peer forwards the query preferentially to the peer with high usefulness. The usefulness of a peer concerning a content is defined by the requested frequency of the content and the elapsed time from its latest update.

In the method called Adaptive Probabilistic Search (APS)[7], each peer maintains a table, which is used for the search of contents and has neighbor peers' indices (i.e. the links to the neighbors) and their usefulness values. A peer decides which peer the query to search a content should be send to, according to the tables when the content is searched. At this time, adjacent peers with a large usefulness value are selected as the transmission destination of the query with a high probability. When the query is transferred, all the usefulness values of the table are decreased by a certain value without any exception. Then, only when the search is successful, the search route is traced in reverse order and the usefulness value of each peer's table corresponding to the link on the route is increased by the value which is more than that reduced when the query transmission. In APS, a neighboring peer, which locates on a lot of routes each of which succeeded in searching for contents in the past, is selected as a query transfer destination with high probability, and the total number of queries can be suppressed compared with a conventional flooding method by decreasing useless queries.

III. Proposed Method

A. Overview

In this paper, we propose an improved method based on APS shown in the former section. Specifically, links between peers and content metadata are searched by an agent traveling around the network, and the tables of indices and values held by each peer are updated based on the searching results. Here, the agent means a process that can freely move among the peers in the network.

B. Detailed Operation

Each agent calculates a route to contents that can be reached with the minimum number of query's hops from current peer based on its searching information included in content metadata. Then the values of the links corresponding to the route on the table are increased and the other values are decreased. When a peer searches for a content, just like APS, referring to its own table, the link with higher value is set to have higher query transmission probability, and the value is updated according to success or failure of the search.

Algorithm of an Agent's Behavior:

1) Deploy multiple dynamic agents in the network.
2) If there exists the information on the shared contents in the peer the agent currently stays in, only the values concerning to the links connected to the peers storing the contents are increased largely, and the other values are all decreased.
3) The agent exchanges the information on the shared contents and adjacent peers' links with the peer. If the information provided by the agent is too much, older information is not exchanged.
4) According to the time stamps of the agents' visiting in each peer, the agent decides the next visiting peer that it visited the most previously.
5) The agent sends all the possessing information to the next peer and it actually moves to the peer.

IV. Evaluation

In this paper, the efficiency of the proposed method is evaluated from the view points such as searching success rate, network cost, and searching efficiency. The proposed method achieves the good result in searching success rate next to flooding. Network costs are reduced the best by the proposed method and APS to almost the same extent. Comprehensively, the proposed method achieves the best result in the searching efficiency.

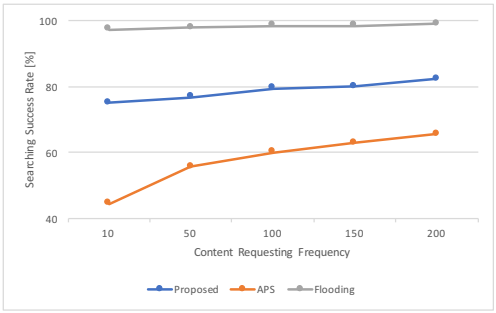

Fig. 1. Relationship between Content Request Frequency and Searching Success Rate.

V. Conclusion

This paper proposes an efficient content sharing within a unstructured P2P network, in which multiple mobile agents circulate in the network and propagate the searched links and content deployment information to each peer in order to reduce the number of wasted queries. The effectiveness of the proposal was evaluated by computer simulations. As future works, we plan to evaluate the proposed method further by setting wide variety of simulation parameters, and also to improve the method by considering more clever agents' movements or propagation ways of contents searching information.

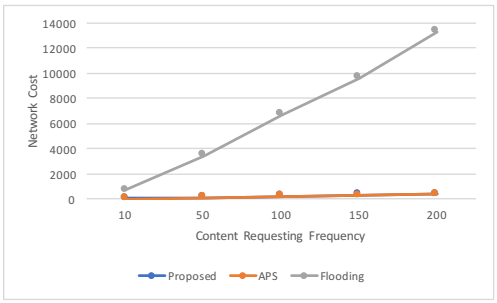

Fig. 2. Relationship between Content Request Frequency and Network Cost.

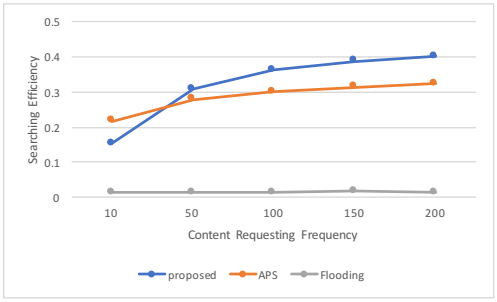

Fig. 3. Relationship between Content Request Frequency and Searching Efficiency.

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