Domain Specific Distributed Search Engine Based on Semantic P2P Networks

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Abstract. This paper presents a distributed search engine based on semantic P2P Networks. The user’s computers join the domains in which user wants to share information in semantic P2P networks which is domain specific virtual tree (VIRGO). Each user computer contains search engine which indexes the domain specific information on local computer or Internet. We can get all search information through P2P message provided by all joined computers. By companies’ effort, we have implemented a prototype of distributed search engine, which demonstrates easily retrieving domain-related information provided by joined computers.

Keywords: Search Engines, Distributed Search Engine, Semantic P2P Networks, Information Retrieve, Local Information Retrieve

1 Introduction

Today, the information such as documents, database, etc on the Servers or local machines are increasing rapidly. How to retrieve the desired information is very important issue for the general users. Although Google or Baidu supply index search engine nowadays, there still some big challenges. Firstly, the search results are not precise by Google or Baidu. Although PageRank[1] introduced by Google get more precise about keywords, the search engines still response much vague results, which are not desired ones for users. Secondly, when the volume of information increases tremendously, the index search engine needs more computers, which will reach the ceiling of computer power and economic feasibility. Thirdly, there are billions of local computers which are behind NAT[2], which is hard to search.

For the above issues, there are some strategies to solve, however, there is no one which can solve all the above problems.

The retrieve information by directory search engine such as Yahoo is more precise, but it takes too much human operations, and it is difficult to automatically handle.

Distributed search engines are able to break the the ceiling of computer power and economic feasibility. There are two kinds of distributed search engines.
the tasks for traditional search engine are scheduled to cluster computers in parallel computation such as Google or Baidu. The other uses P2P technologies. However, the un-structural P2P technology such as Freenet using flooding way has shortage of heavy traffic and un-guaranteed search; the structural P2P technology using DHT such as Chord and Pastry loses semantic meanings. These two kinds of P2P technologies are difficult to implement distributed search engines.

Most search engines do not retrieve information behind of NAT computers. There are lots of users who are willing to share there information in their computers which are behind of NAT.

The goals of DScloud platform are to solve the above problems. DScloud platform based on VIRGO P2P network which hybrids structural and un-structured P2P technologies by merging n-tuple replicated virtual tree structured route nodes and randomly cached un-structured route nodes (LRU and MinD).

In VIRGO framework, the nodes are classified as multi-layer hierarchical catalogue domains according to their contents. The search engine service of DScloud platform includes automatical article digest, automatical domain classification, local search engine and distributed search service.

The following structure of this paper is as follows: section 2 presents overview of Semantic P2P Networks; section 3 describes framework for Distributed Search Engine based on Semantic P2P Networks and its protocols; section 4 presents a primary design of Distributed Search Engine; section 5 discuss security and unlawful search concerns and finally we give conclusions.

2 Overview of Semantic P2P Networks

Semantic P2P networks are based on VIRGO which is a domain-related hierarchical structure hybridizing un-structural P2P and structural P2P technology. VIRGO consists of prerequisite virtual group tree, and cached connections. Virtual group tree is similar to VDHA, but with multiple gateway nodes in every group. Virtual group tree is virtually hierarchical, with one root-layer, several middle-layers, and many leaf virtual groups. Each group has N-tuple gateway nodes. In VIRGO network, random connections cached in a node’s route table are maintained. These cached connections make VIRGO a distributed network, not just a virtual tree network like VDHA. With random cached connections, the net-like VIRGO avoids overload in root node in virtual tree topology, but keeps the advantage of effective message routing in tree-like network.

Fig. 1 shows two-tuple virtual hierarchical tree topology (the nodes in different layers connected with dash line are actually the same node). In Figure 1, from the real network, three virtual overlay groups are organized. From these virtual groups two nodes per virtual group are chosen to form the upper layer virtual group.

In semantic P2P networks, the information are classified according to its domains, and stored in nodes which labeled as related classification domains.
DScloud platform (http://www.yvsou.com) is based on semantic P2P network, in which the users can create domains according to standard classifications of industries, popular classifications or according to their own classifications as fig.2 shows. In DScloud platform, the root domain is ALL, and users can create new sub domains according to their authority. Users can join the sub-domains which they are interested in.

3 Framework for Distributed Search Engine based on Semantic P2P Networks

A hierarchical virtual group tree is built according to domains. Users’ computers join the related groups. Each node has browser, search engine and Web Server besides semantic P2P network protocol implementation. Framework for Distributed Search Engine based on Semantic P2P Networks is as fig.3 shows.

In fig.3, each node implements local search engine which indexes node’s local information in node’s computer.

3.1 Protocols of Distributed Search Engine based on Semantic P2P Networks

Unlike key words as Google, here the search input format is keywords@domain. For example, if we want to search all information which is related with the key word- Windows 10 and within the domain- all.education.undergraduate course.operating systems, so the input will be as: "Windows 10@all.education.undergraduate course.operating systems" [11][12][13].
Fig. 2. Domain classifications of DScloud platform

Step 1 local VIRGO node forwards QUERY MESSAGE to nearer host which joined the same domain as the domain part of the input.

Step 2 the nearer host forwards QUERY MESSAGE to even nearer host until the destination host is found.

Step 3 the destination host retrieve information in the local machine using key word as the same of keyword part of the input;

Step 4 the destination host sends RESULT MESSAGE to original node;

Step 5 original node collects all RESULT MESSAGEs.
4 Prototype Implementation of Distributed Search Engine

The local distributed search engine uses lucene [13] to index and search keywords. The various kinds of documents in the directories under the root directory are extracted by various tools as shown in fig. 4.

The steps of search process of the prototype is as the following:

**Step 1** local browser send QUERY MESSAGE to Local host web server

**Step 2** local host web server parses QUERY MESSAGE and forwards the commands to local VIRGO node.

**Step 3** local VIRGO node forwards QUERY MESSAGE to nearer host with destination host which joined the same domain as domain part of the QUERY MESSAGE.

**Step 4** the nearer host forwards QUERY MESSAGE to even nearer host until the destination host is found.

**Step 5** the destination host retrieve information using keyword in QUERY MESSAGE in the local machine;

**Step 6** the destination host sends RESULT MESSAGE to
original node;

Step 7 original node collects all RESULT MESSAGES;

Step 8 original node sends all information to its local web server;

Step 9 local web server of original node sends all information to its local browser;

Step 10 original node’s local browser displays results;

Step 11 When the original node’s local browser clicks the links of the information, it uses UDP protocol to get the documents through the communications, and displays the documents in the browser;

The prototype project of distributed search engine based on Semantic P2P Networks which will be published in DScloud platform is shown in fig.5.
If the node wants to share files, firstly it joins a domain in the http://www.yvsou.com, then binds its user account with this machine, and puts the files being shared into the root directory. The node needs to run sp2pn.jar. If the other node wants to see the files of this node, firstly, it must run sp2pn.jar in its local machine, and lists all directories of the remote node as fig.6 shown.

When we click the links of shared files in fig.5, then the file will be displayed in browser as shown in fig.6.

5 Privacy, Security and Unlawful Search Concerns

Although distributed search engine we presented may be slower responsive than Google or Baidu, users may still use it for its full information retrieved. However, people may worry about the privacy, security of their computers. And government and companies worry about unlawful information transportation such as porn information, piracy information. In our prototype, we limit the working directory and its sub-directories as search directory. The search engine only retrieve these directories. We also use trusted computing technologies to keep the integrity of the program to defend hacks’ stealing and cheating information. The
government and companies can inform against the users who support unlawful information because all users who support information have account. We can easily track and block the users with supporting unlawful information.

6 Conclusion

We here present framework and prototype of implementation of a distributed search engine based on semantic P2P networks. This framework has potential to solve the problems such as less precise search results, the ceiling of computer power and economic feasibility and information retrieve of local computers which are behind NAT. Although distributed search engine we presented may be slower responsive than Google or Baidu, users may still use it for its full information retrieved. We also discuss the strategy to solve the problems of the privacy, security and unlawful information.

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Fig. 7. Display file from remote node

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