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Dynamic Resource Discovery protocol in Unstructured Peer-to-Peer Networks

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Abstract—Designing efficient search algorithms is a key challenge in unstructured peer-to-peer networks. Flooding and random walk (RW) are two typical search algorithms. Flooding searches aggressively and covers the most nodes. However, it generates a large amount of query messages and, thus, does not scale. On the contrary, RW searches conservatively. It only generates a fixed amount of query messages at each hop but would take longer search time.We propose the dynamic search (DS) algorithm, which is a generalization of flooding and RW. DS takes advantage of various contexts under which each previous search algorithm performs well. It resembles flooding for short-term search and RW for long-term search. Moreover, DS could be further combined with DDRP search mechanisms to improve the search performance.We analyze the performance of DS based on some performance metrics including the success rate, search time, query hits, query messages, query efficiency, and search efficiency.

Keywords-Unstructured Peer-to-Peer networks; Resource, discovery; Dynamic-TTL; P2P computing

INTRODUCTION

In unstructured peer-to-peer (P2P) networks, each node does not have global information about the whole topology and the location of queried resources. Because of the dynamic property of unstructured P2P networks, correctly capturing global behavior is also difficult. Search algorithms provide the capabilities to locate the queried resources and to route the message to the target node. Thus, the efficiency of search algorithms is critical to the performance of unstructured P2P networks [3]. The first part focuses on a comparative study of the proposed scheme with the flooding and random walks approaches under a set of performance metrics. The second part analyzes the impact of DRDP parameters on its performance. A cycle based simulator [21] was used for both modeling the network topology and simulating the behavior of different approaches in a Grid environment.

DRDP EVOLUTION

In the context of Grid system, resources are characterized by their diversity. In such system, users often need to discover software or hardware resources based on extensible set of resource descriptions. When submitting a job, users has to specify its requirements like memory, disk space, operating system. In the following, we consider a P2P Grid environment with a set of N peers where grant peers offer resources such as free disk space, CPU cycles, memory, etc. A user issues a query q through so called search peers and provides a description of the required resources R = (r1; r2; :::rx). It can be a single resource (e.g., storage resource)or a set (e.g, storage resource AND a computing resource) of independent resources. When receiving a request, a grant peer looks whether it matches any of its available resources R = (r1; r2; :::ry). If so, matched resources are removed from the request and an acknowledge message is sent back to the search peer. The query, wit the remaining resources, is then forwarded using the chosen scheme (flooding, random walks, DRDP). Note that, in our simulations, all requests are generated such that for each requested resource r there is at least one matching resource r provided by the network.

The parameters that determine the simulation scenariosfall into three basic classes: network topology, querying model and resource distribution. Network model. In the simulation study presented in this paper, we mainly use random graph topologies. Message distribution. In DRDP approach two basic messages are generated: request messages and grant messages. However, in flooding and random walks approaches only request messages are generated. In all approaches, we use exponential distribution as a message generator model, i.e., the time interval (in simulation cycles) between two consecutive messages generated by a given peer follows an exponential distribution. Resources. The role of each peer is randomly assigned at start up time based on the grant nodes (Ng) and search node (Ns) parameters. Without any loss of generality, we have used integers to describe resources during the simulation. The number of different resource classes is specified through the number of resource classes (rc). The maximum number of resources that a peer can request in a single query is defined by number of requested resources per query (nsr). A search peer sends a query and waits for replies from grant peers. Each grant peer holds a set of resources. This number is randomly selected at initialization time and is specified by number of resources per grant peer (ngr). Unless stated otherwise, simulations are based on the default parameters

SIMULATION RESULTS

Due to the high number of parameters, it was not possible to include all simulation results. In the remaining of this section, only a subset of these results is presented.

1) Baseline scenario: This simulation scenario used the simulation parameters reported in Table II. The simulation parameters have been selected to fit a plausible Grid scenarios. In particular, the wide range of resource classes, cr, reflects the resource heterogeneity in such an environment. Moreover, the choice of the TTL value strongly depends on the network size. As we simulate a network of 10000 nodes, the ttl value was set to 3 (ttl = 3). A large TTL would result in covering almost all of the nodes when using the flooding scheme, which is unrealistic. Moreover, a low value of the TTL parameter may not provide a fair comparison of the random walk technique with both flooding and the DRDP approaches. For this reason, we kept the same configuration for the random walk approach and run additional simulations where the TTL value was set to 15. We assume for each generated query, a search peer requests nsr distinct resources randomly selected such as nsr 2 [1□5]. As aforementioned, the search is considered as a success if and only if the nsr resources are found. The replication ratio, p for all resources available in the network does not exceed 0:009 as shown in Figure 4. Our objective through this scenario was to simulate the situation where a peer can not only request n distinct resources within a query but also requests scarce resources. Figure 5 displays the success rate (s) during simulation time. Before conducting a deeper analysis of these results, we have to underline that the probability of a failed search increases with the number of requested resources in a single query. In that situation, a peer could succeed in locating a subset of the needed resources but not all of them. As we can clearly see, at the beginning of the simulation period, DRDP and flooding schemes reach almost the same success rate. However, in steady state, DRDP achieves the highest success rate (around 0:57) and outperforms not only flooding (0:45) but also the random walks (k = 15, ttl = 3, ttl = 15) scheme in terms of successful searches. This can be explained by the fact that at the start phase, caches are almost empty (cold cache phase). So, as in the flooding approach, queries are sent to all neighbors and the TTL is decreased by 1 at each forwarding step (see Table I). Later, once peers build their per-link caches, and thus learn more information about the available resources in the network.

CONCLUSION

We have proposed in this paper two schemes to improve the search in unstructured peer-to-peer networks. First, simple caches are associated to each link of a peer. These caches only store the resource description, not the owner, maintaining a small footprint and allowing aggregation. Second, a dynamic TTL scheme removes the horizon limitation of messages which are more likely to reach a peer providing the needed resource. They do not require a complex coordination between peers and can thus be added to existing informed search protocols to improve their performance. To demonstrate the usefulness of these mechanisms, we have designed a simple search protocol, called DRDP, and investigated its performance through simulations reproducing a realistic application. Compared to flooding it yields to a lower number of messages despite the grant messages sent by peer holding resources. Compared to random walks, it greatly improves the success rate, especially with scarce resources or complex queries. Although simple in design, DRDP proves complex to analyze due to the high number of parameters involved. Futher experiments may be carried out to evaluate the performance and scalability of our approach. This includes a dynamic network (i.e., peer churn) and adaptive tuning of DRDP parameters.

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