Implementation of Resource Discovery Mechanisms onto PeerSim

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ABSTRACT

Resource discovery is an important part of distributed computing and resource sharing systems, like grids and utility computing. The role of resource discovery is extremely important for peer-to-peer (P2P) systems. However, many researchers fail to list down how the implementation and tests on P2P simulator have been done. This paper discusses the implementation of resource discovery techniques such as random walk (RW), restricted random walk (RRW), breadth-first search (BFS), intelligent BFS (Int-BFS), depth-first Search (DFS), adaptive probabilistic search (APS), and blackboard resource discovery mechanism (BRDM) onto PeerSim, a P2P network simulator that is able to simulate large P2P environment. Brief information about each resource discovery techniques that are implemented onto PeerSim are discussed and presented.

KEYWORDS

Resource discovery, Peer-to-peer, Simulation, BRDM, PeerSim.

1 INTRODUCTION

Resource discovery is one of the most important parts in any resource sharing systems [1, 2]. Nowadays, the most used resource sharing methods are the peer-to-peer (P2P) systems. Resources shared in P2P systems are usually spread all over the Internet. Resource discovery plays a more vital role in P2P, because unlike client-server architecture, P2P does not possess a central computer storing all the resources.

There are several researches have been done to simulate the resource discovery techniques on a P2P network [1, 2]. However, those researches didn't specify the exact simulator that being used, and the amount of nodes that being tested on the P2P simulator.

The purpose of this paper is to add several available resource discovery mechanisms onto PeerSim [3] so that it will provide a platform for future researches to do further simulation and testing of each developed protocols. Developing the mechanisms on PeerSim enables a vast amount of P2P nodes to be generated. Thus making the resource discovery mechanisms simulation nearer to the real-life application.

This paper discusses several resource discovery mechanisms that we implemented on PeerSim for testing with the P2P simulated environment in section two. In section three, we discuss PeerSim simulator briefly. Expected results were presented in the fourth section. The conclusion and future works are presented in the final section.

2 RESOURCE DISCOVERY

Resource discovery techniques have been studied even before the existence of computer networks. Various techniques that being used today are the improvements of previously developed resource discovery methods.

Techniques such as Random Walk [4], Restricted Random Walk [5], Breadth-First Search [6], Intelligent BFS [7], Depth-First Search [8], Adaptive Probabilistic Search [9], Blackboard

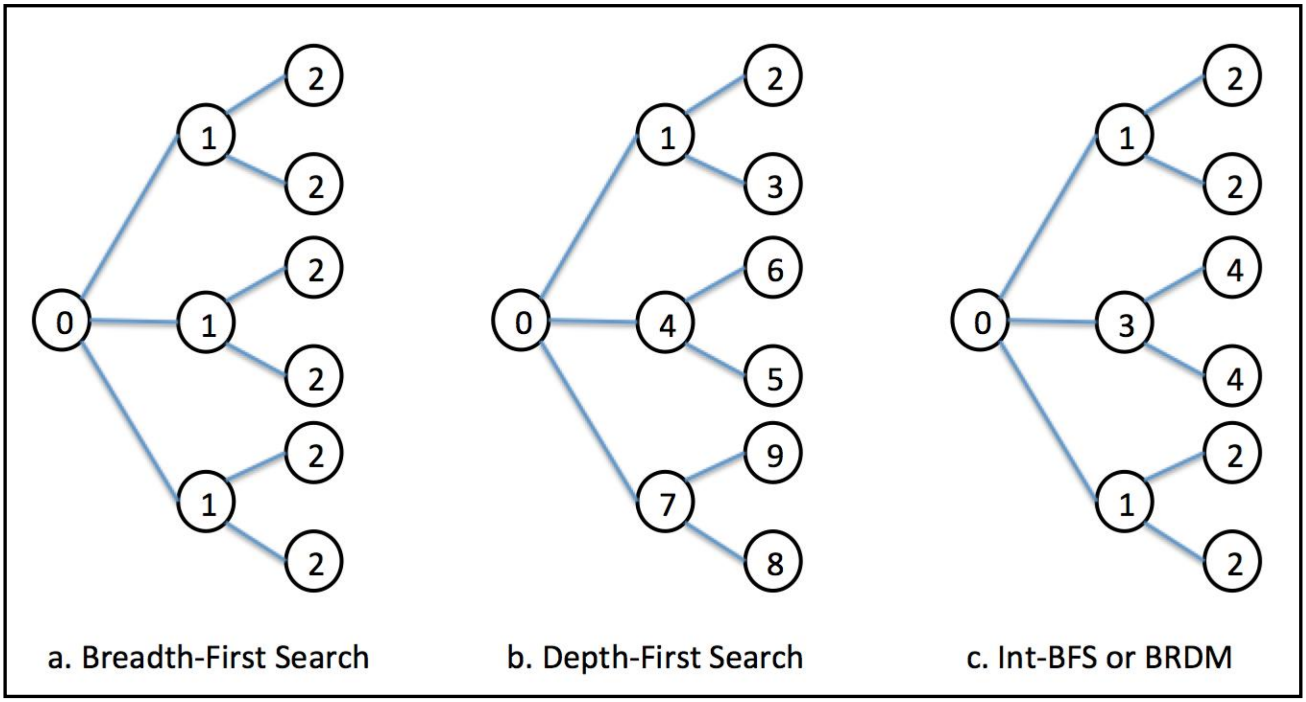

Figure 1. The sequence of selecting adjacent nodes for each resource discovery mechanism.

Resource Discovery Mechanism [10] are explained briefly in the following subsections.

2.1 Random Walk (RW)

Random walk [4] is an easy method to locate resources. When one node is searching for a resource, the node will check for the resource at its current location. If the resource is not available, the node will send a walker (query) to one adjacent node. The selection of adjacent node the walker should go next is decided randomly, thus the name of the method.

The search will be done recursively until it finds the resource that it was looking for. There are no restrictions in RW, therefore there is a possibility that the walker will go back to the node that the walker has been visited previously [4].

2.2 Restricted Random Walk (RRW)

Restricted random walk [5] represents an improvement upon random walk resource discovery mechanism. It carries most of the criteria of a RW, however, the only differences are when the walker (query) is selecting the adjacent node to go to.

RRW's walkers will randomly select an adjacent node that it has never visited before. Therefore in order to run RRW, the walker will keep track all of the nodes that it has visited.

The ability to omit the nodes that it has visited makes the RRW a better method than RW because it does not waste the time-to-live (TTL) of its walkers.

2.3 Breadth-First Search (BFS)

BFS is among the earliest resource discovery techniques that being used in the field of computer networks. In P2P networks, when a node is searching for a resource, it will check itself whether it has the requested resource. If not, the node will query all adjacent nodes for the resources [6].

BFS uses a lot of networking resources by sending a large amount of queries inside the network. This characteristic makes BFS looks like it is flooding the network with queries. That is the reason why BFS discovery method is also known as flooding [5]. **Figure 1a** shows the sequence of walkers being generated using the BFS technique.

2.4 Intelligent BFS (Int-BFS)

Intelligent BFS [7] is an advancement of BFS [6] searching technique. Int-BFS does not flood the entire network. Instead, it only sends walkers to a fraction of its adjacent nodes. The fraction changes according to the topography and number of adjacent nodes.

In Int-BFS, the node will store query information regarding how many times that the adjacent neighbour has been answering the majority of queries sent by the node.

When a new query arrives, the node will search the stored queries that it has, and forwards it to a set number of neighbours that have answered the most results for the query. **Figure 1c** shows the sequence of walkers using Int-BFS. Observe that the technique uses random, therefore the results would not be like that in every simulation.

2.5 Depth-First Search (DFS)

Depth-first search [8] can be viewed as the opposite of BFS [6]. Instead of forwarding queries to all adjacent nodes, DFS only forwards one walker to one adjacent node.

The selection of the forwarding node is done randomly. The query will continue on forward until it can not find any other adjacent node that it has not visited. When it reaches the end (where there is no other choice), the walker will take one step back to the previous node that it visited, and then continues to go forward to another adjacent node.

Figure 1b shows the route sequence that a DFS walker would choose during the resource discovery. Observe that the technique uses random therefore the results might differ every simulation cycle.

2.6 Adaptive Probabilistic Search (APS)

Adaptive probabilistic search [9] is a modification of random walk [4]. In the initial stage, APS works just like RW, where all adjacent nodes have an equal probability to be selected.

The probability of an adjacent node increases when it returns a hit for any query. Alternatively, the probability to be selected decreases if the adjacent node did not return any successful searches [9]. For this reason, APS searching capabilities improve over time.

2.7 Blackboard Resource Discovery Mechanism (BRDM)

Blackboard resource discovery mechanism was first coined in 2004 as a method that utilises an artificial intelligence technique called blackboard [10]. The blackboard technique is when we list down all the important information about neighbouring entity.

In BRDM, the blackboard is used to list down recommendable adjacent nodes to forward a future query. If there is a recommended node, the query will be forwarded to the node, if there aren't any recommended nodes, the query will be forwarded to a number of random adjacent nodes.

BRDM forwards queries using walkers. The amount of walkers is decided based on the TTL of the query and the amount of adjacent nodes. The percentage of neighbour to forward the query can be modified to suit the topology of the P2P network.

BRDM is utilised as one of the efficient scheduling policy for ParCop, a decentralised P2P system [11]. **Figure 1c** shows the sequence of walkers using BRDM. Observe that the technique uses random, therefore the results would not be like that in every simulation.

3 PEERSIM

PeerSim [3] is a Java-based P2P network simulator. The simulator excels in generating large number of nodes (up to 1 million) in order to test and simulate a real-life P2P network. PeerSim project was initiated under EU projects BISON and DELIS. PeerSim development is now partially supported by Napa-Wine project.

PeerSim has been developed with extreme scalability and dynamicity in mind. It consists of two simulation engines, one is cycle-driven and the other one is event-driven. In order to choose the right engine for the simulation, one needs to figure out which characteristics are the most important in the simulations that are about to be done.

Table 1. Network overhead and successful searches of each resource discovery techniques in a random P2P topology.

Techniques	Network Overhead	Successful Searches
Random Walk (RW)	□□□	□
Restricted Random Walk (RRW)	□□□□	□□
Breadth-First Search (BFS)	□	□□□□□
Intelligent BFS (Int-BFS)	□□	□□□□
Depth-First Search (DFS)	□□□	□□
Adaptive Probabilistic Search (APS)	□□□	□□□□
Blackboard Resource Discovery Mechanism (BRDM)	□□□	□□□□

3.1 Cycle-Driven Engine

Cycle-driven engine is simplified assumptions of a P2P network. It ignores the details in the transport layer of the OSI network model.

The reason for omitting the transport layer simulation is to enable scalability of the network, and to use as low computing resources as possible for the simulation. Cycle-driven engine is less realistic when compared to the event-driven simulation engine.

3.2 Event-Driven Engine

The event-driven engine was developed in order to cater to a more realistic simulator. Unlike the cycle-driven engine, the event-driven engine also enables OSI transport layer simulations.

In order to provide more realistic simulations than the cycle-driven engine, the event-driven engine is less efficient and uses a lot of computing resources. The amount of nodes can be simulated in this engine is usually lesser than cycle-driven engine, and the simulations are generally slower.

All cycle-driven simulations can be implemented in the event-driven engine, but not vice versa.

3.3 Reasons For Choosing PeerSim

The main reason for choosing PeerSim as the simulator platform is because PeerSim is able to simulate large number of P2P nodes. This ability is important in P2P network simulation because it will truly reflect the real life environment of a vast P2P network [12].

The other reason for choosing PeerSim is because it is supported by several international fundings and programming community. The software has been used in P2P researches, and the ability to utilise either the cycle-driven or event-driven engine for its simulation is very useful.

4 EXPECTED RESULTS

We expect that the results will be coherent with the claims that each resource discovery technique claims. We will be able to get the data on the network overhead, successful and unsuccessful searches, average TTL of each resource discovery techniques. **Table 1** shows the network overhead and successful searches of each resource discovery mechanism in a random P2P topology.

By utilising PeerSim as the platform, we can upscale the simulation to be running several thousand nodes, compared to other simulators that usually run to the maximum of a couple of hundred nodes.

5 CONCLUSION & FUTURE WORKS

The implementation of resource discovery techniques onto PeerSim is an important step in ensuring that a resource discovery protocol is viable to be used in real-world P2P environment. Previous simulation that usually keep into consideration only several hundreds nodes might lead to a protocol that is network resource hungry.

If these network resource hungry technique were to be implemented in real-world P2P environment might lead to a network flooding. Thus, flooding might cause a network to slow down or ultimately towards network downtime.

The implementation of resource discovery techniques onto PeerSim will be the first landmark in making a low-cost, and higher amount of successful searches resource discovery mechanisms.

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