

Searching Optimization in P2P Distributed System

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Abstract— Decentralized and unstructured peer-to-peer networks such as Gnutella are attractive for certain applications because they require no centralized directories and no precise control over network topology or data placement. However, the flooding query algorithm used in Gnutella does not scale; each individual query generates a large amount of traffic, hence large systems quickly become overwhelmed by the query. This paper proposes an alternative searching approach to optimize the existing searching methods used in the enhanced iPTF that includes Rendezvous election and peers distribution process, and overlay network construction in order to produce a robust P2P radios automated testing system including PCR two-ways radios especially MotoTRBO™ testing environment. Load balancing concept is the main consideration applied in this proposed system. All the processes mentioned for the proposed system above basically are to distribute the loads of a rendezvous peer to another newly elected rendezvous in order to form an overlay network and improving the searching performance.

Keywords— Load balancing, searching, optimization, iPTF, CCP Tester, Gnutella, JXTA™

I. INTRODUCTION

Peer-to-peer (P2P) Network enables resources distribution that allows more than one individual computers or nodes to achieve a higher throughput, increases reliability by eliminating reliance on centralized coordinator that is potentially a critical point of failure, and maintains the comprehensiveness of information.

Efficiently in determining a node that stores a data item in a distributed network especially in P2P Network is an important and challenging problem. Nowadays, a huge number of machines or computers in the global are trying to share resources with each other in P2P environment. The efficiency of searching process or discovering the information is very important in resource sharing. The searching process becomes inefficient (such as consumes longer time in searching and also expensive in term of overhead, and storage redundancy) if the normal searching process is implemented - web crawler approach. One of the solutions is to provide indexing services for all contributed resources. This will speed up the resource searching process and all the repositories can be maintained easily.

Paper [1] described an end user is not able to retrieve the content unless he knows its unique name in peer-to-peer systems. On the other hand, the web services allow this to be done by actively and repeatedly indexing the Internet contents by following hyperlinks from one resource to another. The web's current search infrastructure is limited by its centralized design. However, the peer-to-peer searching can be entirely distributed, and thus more scalable and reliable.

This paper basically proposes an optimized searching approach in P2P network. It can be adopted in the radios automation testing system - the enhanced iPTF (iDEN™ Phones Test Framework) [2][3] and CCP Tester from PCR (Professional and Commercial Radio). This paper is presented as follows: Section 2 describes some related works and motivations. Section 3 explains domain issues in existing systems. Section 4 goes into the proposed design methodology and framework which details the rendezvous election and peers distribution processes. Section 5 discusses research findings and actual results obtained from the simulation tests. Section 6 goes into the advantages and disadvantages of a Proposed System followed by the Conclusion in Section 7.

II. RELATED WORKS AND MOTIVATIONS

Many research activities in peer-to-peer file sharing system had been done after the introduction of Napster [4]. For instance, Gnutella [5], Freenet [6], Chord [7], JXTA™ [8][9], BitTorrent™ [10], etc. However, only a few approaches will be discussed briefly in this paper.

Napster [4] is the first generation of the peer-to-peer file sharing platform that employs the centralized model of p2p file sharing. The central server of Napster maintains directories of the shared files that have been indexed and stored at each registered peer of the current network. File indexing enhances the searching process as the shared file can be located quickly in P2P network due nil request messages forwarding to peers are needed to locate shared files. Hence, the network bandwidth utilization can be reduced significantly. However, this model tends to cause single point of failure which will cause all of the Napster's clients to cease communication. [11]

Gnutella [5] is a protocol for distributed search in P2P network based on decentralized model. In this model, every peer is a server and vice versa. These peers can issue queries and view search results; while at the same time they can also accept queries from other peers, check for matches against their local data set, and respond with applicable results. In short, Gnutella protocol is highly fault-tolerant, as there is no single point of failure. The setback of this protocol is Gnutella implements the flooded requests model in searching.

CPM is built on top of JXTA™ framework. It inherits the default searching methodology for the JXTA™ framework in the form of JXTA™ Search [8][9]. In CPM (Compute Power Market) [12][13] network, the provider will publish an advertisement to the rendezvous to announce its availability to all the consumers after joining the network. This advertisement indicates all the services offered. The rendezvous will then maintain a list of the advertisements that was published by all the providers within its network. The consumer can, then request for any service available by posting a query to its connected rendezvous. The rendezvous tries to resolve the query received by referring to its maintained advertisements list (local cache). Once the query is resolved, it will return a list of the peers (providers) -which have the services that required- to the query originator (consumer). The consumer will choose the provider it likes and requests the service from it (provider). However, if the query cannot be resolved, it will not return any list to the consumer.

The iPTF [2][3] is currently the standard test tool used by Motorola® test team to execute test scripts locally and on remote sites where all the iDEN™ phones or product-under-test is located. Paper [2][3] described the existing iPTF framework that had been enhanced and adapted in the P2P computing system with JXTA™ technology. It can fully utilize the idle resources with the help of distributed Job Scheduler. As enhanced iPTF is built on-top of JXTA™, thus, it inherits the searching algorithm from the JXTA™.

III. PROBLEM DOMAIN DESCRIPTION

Every searching algorithm or searching methodology has its pros and cons. The centralized searching in Napster stores all information into one same repository. Hence, the indexing can be done easily. Its setbacks, a single point of failure and overloaded (processor) – can happen in the particular peer as all peers are accessing to the same repository to obtain information. On the other hand, the decentralized indexing in Gnutella will increase network bandwidth utilization. This is because it broadcasts queries to the network. The consequence; every peer has to waste some resources in handling irrelevant queries [14]. In order to cater these problems, an efficient searching method to reduce the network bandwidth utilization is needed; for instance, reducing the frequency of broadcasting query messages to all peers in the Gnutella network is necessary.

The enhanced iPTF's searching approach is based on the hybrid networks architecture. Paper [8] and [15] thru [19] presented and examined some similar design systems in various aspects. The most obvious issues in the existing system is; once the provider (a server with radios under test connected) joins the enhanced iPTF's P2P network, the provider will publish its resource advertisement to the iPTF's rendezvous / market. If the consumer (a peer that may request some services from the providers) would like to request some services from the providers, the consumer will publish its queries to the rendezvous. Rendezvous will maintain a list of advertisements that was published by all the providers. However, when providers and consumers increase dramatically- as shown in Figure 1 - the advertisements in the market / rendezvous repository will increase dramatically as well. The rendezvous can be overloaded as it has limited processing power to process more queries from consumers. As a result, the rendezvous' performance is affected significantly, such as slow in processing queries that posted by the consumers. In paper [20], a machine with Intel Pentium III 930MHz processor requires about 2 millions clock cycles when processing one query with the size of 100 bytes in local database. It is equal to approximately 500 queries per second limit or 50 kilobytes per second. The author believes that the performance still can be improved if better searching algorithm or approach is used. Hence, an optimized searching algorithm is proposed in this paper to address this issue in the P2P environment. The basic idea is to construct an overlay network by employing Rendezvous Construction concept when the existing rendezvous is overloaded. This approach is trying to distribute or spread over the loads of the existing rendezvous (load balancing) in order to maintain its stability (such as the machine is not going to shutdown, the network will not be congested by all the queries) and to effectively process the queries. At the same time, the proposed system will still maintain all the advantages of JXTA™ (the existing framework of enhanced iPTF).

IV. PROPOSED DESIGN METHODOLOGY

A. Rendezvous Election and Peers Distribution

The solution is to distribute the resource advertisements [21] from the existing overloaded rendezvous to the new elected rendezvous by achieving load distribution, load balancing and maintaining the respond time in resources (resource advertisements) searching.

The distribution of resource advertisements from one rendezvous peer to another rendezvous peer, or also known as "providers' distribution" process, will begin when the existing rendezvous is overloaded (exceeded the number of connected peers that it can support). In this paper, some low random numbers of peers such as 5, 10, 15 and 20 peers had been chosen to prove that the searching performance in P2P still can be optimized. Theoretically, the number of queries that a rendezvous can execute at a particular time can be estimated with the equation 1 below. The measurement unit used to quantify the capability of the machine in this paper is mflops

(million floating operations per second). In order to obtain every machine's performance in mflops (a), a benchmarking application is used to benchmark all 6 test machines in the lab. The number of floating operations (c) are needed to execute a query can be calculated after getting the execution time of one query (b).

$$\begin{bmatrix} \text{Number} \\ \text{floating} \\ \text{operations} \\ \text{(c)} \end{bmatrix} = \begin{bmatrix} \text{machine} \\ \text{capability in} \\ \text{mflops,} \\ \text{(a)} \end{bmatrix} \times \begin{bmatrix} \text{execution} \\ \text{time of 1} \\ \text{query,} \\ \text{(b)} \end{bmatrix} \quad (1)$$

Once the number of resource advertisements increased and exceeded the upper limit (this number is known because the rendezvous is keep tracking the number of the resource advertisements that published by all the providers that connected to it) of a particular rendezvous which can handle, the information comparison is performed to determine the most capable peer (a peer that can process the most queries) to be a new rendezvous. The information such as processing/computing power, processor speed, memory, etc. is retrieved from its local cache. The most capable peer is elected as a new rendezvous is based on the bandwidth needed to process every query within the network. The bandwidth can be reduced if every query can be resolved locally and needs no further forward to other rendezvous which might congest the network. This is trying to achieve load balancing in P2P network environment. Figure 2 illustrates a rendezvous is trying to determine which peer is capable to become a new rendezvous. Another way to handle this issue is described in paper [22] - a lightweight, robust P2P system to handle flash crowds.

After a new rendezvous is elected and before the new overlay network can be constructed, updating both new and existing rendezvous repositories are required to maintain all connected peers and newly joint peers respectively to every rendezvous. This process is illustrated in Figure 3. Figure 4 illustrates a newly overlay network is constructed at the end of the process.

The purpose of maintaining the connection between the new rendezvous and the existing rendezvous is to ensure the islanding issue will not happen as the relationships or connections between providers, rendezvous and consumers varies from time to time. Moreover, the rendezvous construction process will be executed continuously when overloaded happens. In addition, the searching performance can be further improved as well because all unresolved queries in the existing rendezvous will be forwarded further to the rendezvous peers only rather than forwarded to all the peers within the P2P network like Gnutella network.

One of the main advantage of the proposed design is the whole system becomes more robust. For example, if one of the rendezvous failed, all its peers are allowed to resort or

join back to one of the existing rendezvous. In consequence, the single point of failure is eliminated.

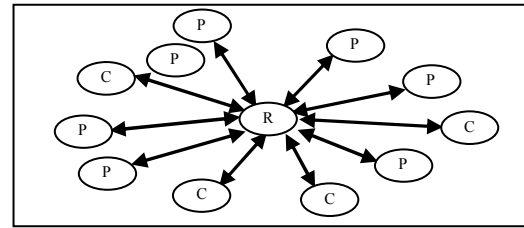


Figure 1: Enhanced iPTF network (providers increase dramatically)

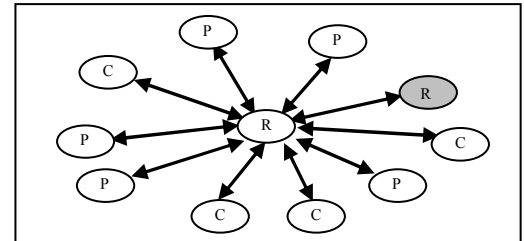


Figure 2: Rendezvous determines which peer can become a new rendezvous

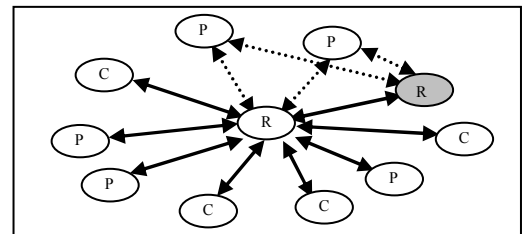


Figure 3: A new rendezvous sends a message to all peers in its advertisement's list sent by the existing rendezvous

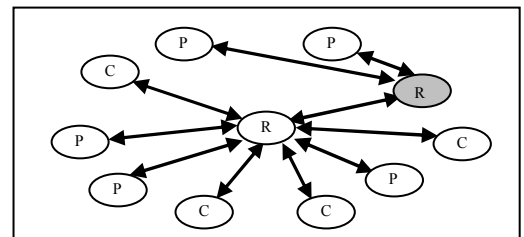


Figure 4: Responded peers will be assigned to a new rendezvous and overlay network is constructed successfully

Where

(R) Existing Rendezvous

(R) New Elected Rendezvous

(C) Consumer

(P) Provider

←...→ Communications

↔ Communications

V. RESEARCH OUTCOMES

Some experiments had been carried out by publishing 1000, 2000, 3000, and 4000 resource advertisements into the rendezvous peers and remote peers; to perform remote and local discovery services by searching certain resource advertisements that requested by the consumers. The response

time of each search is then being recorded and searching performance' graphs have been plotted as below. The purposes of these experiments are to observe if various searching can be performed in parallel and to observe if the rendezvous is getting overloaded when queries increase dramatically.

Table 1 shows the hardware that used in the testing. All results are repeated at least 3 times and the average is calculated for each test in order to have more precise results for graphs' plotting.

A. Simulation Results Discussions

Results illustrate resource advertisements are not utilizing a lot of resources (storage) of every peer. However, the most critical resource needed is the peer's processing/computing power. The peer is running out of the processing power when processing more and more queries. The peer is described as overloaded in this case. In addition, results also indicate the proposed design (Rendezvous Election and Peers Distributions approach) has better performance in resource advertisements searching compared to the normal single rendezvous searching. Figure 8 illustrates this more clearly.

Table 1. Model of machines used in testing

Model of Machine	Number of Peers Running
Pentium 4 2.4 GHz 512DDR Ram	5
Pentium 4 2.4 GHz 512DDR Ram	5
Pentium 4 2.4 GHz 512DDR Ram	5
Pentium 4 1.6 GHz 512 DDR Ram	2
Pentium III 800 MHz 512SD Ram	3

From the graphs beside, the searching performance is getting better when the number of data searching (resource Advertisements) is increased. By distributing the number of the connected peers to other new group, the system resources can be utilized more efficiently especially in information searching. This is because loads of a peer group can be distributed to the new replicated group. In this case, load balancing can be achieved effectively as all peers could perform searching (discovery service or resolving all the queries) in parallel.

Graph in Figure 5 illustrates the normal single rendezvous searching is better than the proposed distributed approach. The reason, the peer is capable enough to perform small numbers of peers searching. It is better to have single list of advertisements searching if the rendezvous is not overloaded as this can reduce the communication cost amongst the peers. The distributed approach searching performance becomes better when the number of data searching increases dramatically which can be seen from Figure 5 to Figure 8. Hence, the upper limit of resource advertisements that a particular machine or rendezvous can handle needed to be set

carefully (based on the peer's capability) in order to have optimum performance.

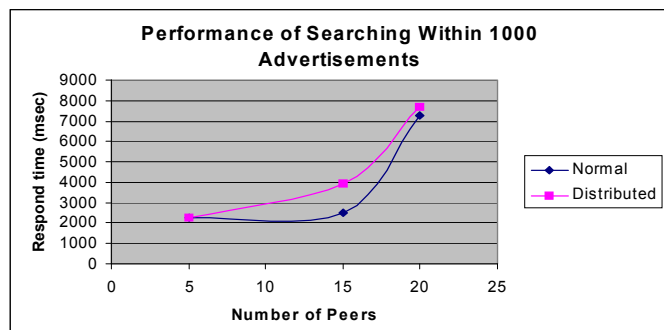


Figure 5: Graph Respond Time vs Number of Peers Searching Within 1000 Advertisements

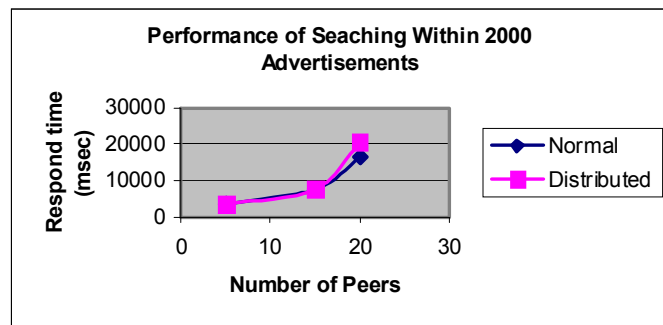


Figure 6: Graph Respond Time vs Number of Peers Searching Within 2000 Advertisements

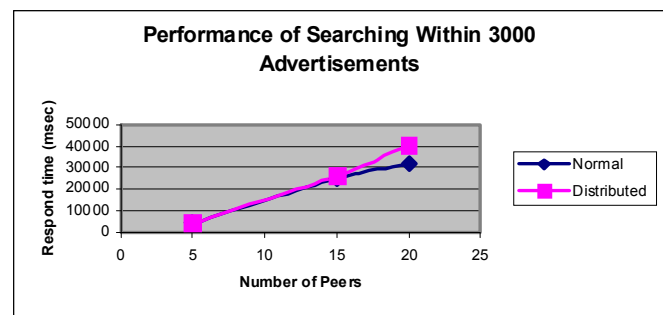


Figure 7: Graph Respond Time vs Number of Peers Searching Within 3000 Advertisements

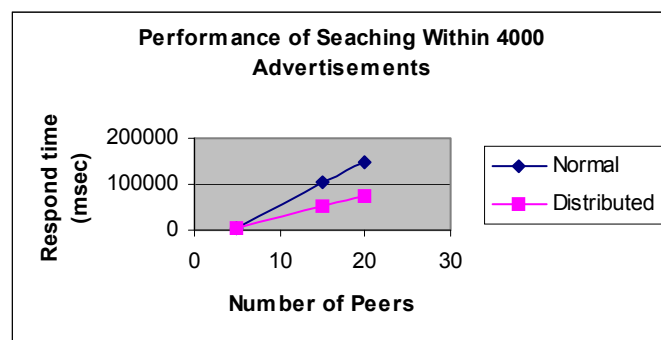


Figure 8: Graph Respond Time vs Number of Peers Searching Within 4000 Advertisements

For instance, if the number of advertisements is less than 4000, single list of advertisements searching is used. Otherwise, the distributed approach searching is utilized.

B. Research Outcomes / Findings

- Resource discovery or searching takes from few seconds to few minutes depending on the size of the repository. The result can be found at section A above under Research Outcomes.
- Experiments were carried out within the local area network to enable the peer to discover the other peers easily and faster compare to the real network (Internet).
- The respond time increased if the discovery service is performed remotely. Reliability is assured in this case as the advertisement still can be found although this information does not resides in the local cache but exists within the network.
- Most of the resources used are from advertisements searching. And the machine will get overloaded once there is a lot of searching being performed.
- This research is trying to prove that the proposed idea is workable. However, this is not an actual performance of a peer per machine as we had created few peers in a machine because of constraint by the testing environment.

VI. ADVANTAGES AND DISADVANTAGES

A. Advantages

- Load balancing - able to distribute the loads of the peer to non-overloaded peer in order to optimize the searching performance.
- A more robust and fault tolerance system can be produced as there is no single point of failure with rendezvous election and overlay network construction implementations.
- Scalability - an overlay network can be constructed when there is a rendezvous is overloaded.

B. Disadvantages

There is communication overhead amongst peers before and after the rendezvous election and overlay network construction. However, the performance is still better than TTL implementation in Gnutella network.

VII. PCR IMPLEMENTATION

What is PCR? PCR stands for Professional and Commercial Radio. This is one of the great business sectors in Motorola®. In this paper, we focused only on PCR radio products, MotoTRBO™. MotoTRBO™ is Motorola's first digital conventional two-way radio system with better basics and enhanced features and performance specifically designed to meet the requirements of professional organizations that need a customisable, business-critical communication solution using licensed spectrum. MotoTRBO™ offers a private, standards based solution that is both cost effective and easily tailored. In short, MotoTRBO™ offers a complete

package for the organization's unique communication needs. Figure 9 illustrates mobile MotoTRBO™ while portable MotoTRBO™ is shown in Figure 10.



Figure 9: MotoTRBO™ (mobiles)



Figure 10: MotoTRBO™ (portable) with accessories

The research showing that with P2P Distributed System testing environment, it is possible to improve PCR testing performance. Currently, the PCR box test team is using third party automation tool in their automation testings. There is some cost incurred for purchasing these third party tools. Moreover, every automation system is able to communicate with 8 radios only at the same time. How about if there are more than 8 radios needed to be tested? The option is to purchase additional automation system. So, in order to avoid some expenses, we have to explore other options. In this case, CCP Tester is been selected because the core functionality is similar to iPTF in generally. We can replace iPTF above mentioned with CCP Tester as our automation tool. CCP Tester is a protocol conformance test tool to verify some radio-protocols-handler of LTD radios. It is Motorola® internal automation tool. It supports some famous protocols such as TCP, UDP, and RS232, including Motorola® defined protocols. CCP Tester is now support more than one radio connection at the same time, SMS and AT debug testing. It executes TCL scripts locally where all the PCR radios located. Figure 9 illustrates CCP Tester application.

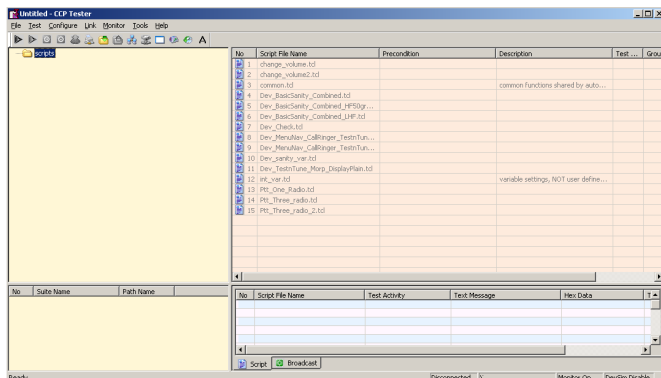


Figure 11: CCPTester

VIII. CONCLUSION

In conclusion, this paper studies Searching Optimization in P2P Distributed System for radios Automated Testing Environment. A research is done to optimize the performance of the existing searching algorithm used in the enhanced iPTF and CCP Tester. The paper presents comprehensive rendezvous election and peers distribution process, and constructing an overlay network in P2P network in order to optimize the resource searching performance while maintaining all the advantages of the JXTA™ Search. The proposed system is trying to reduce unnecessary flooding query messages and bandwidth utilization in P2P network as well. This design can be used for any Motorola® radios testing to achieve maximum performance.

REFERENCES

- [1] Patrick Reynolds, Amin Vahdat, "Efficient Peer-to-Peer Keyword Searching", Duke University.
- [2] Wei Hoo Chong, "Automated Testing in P2P", Motorola Technical Journal 2nd Issue, Motorola Inc., 2007.
- [3] Wei Hoo Chong, "iDEN™ Phones Automated Testing in P2P", International conference on Networking and Services (ICNS'06), San Jose, p. 105, 2006.
- [4] Tyson, J. How the Old Napster Worked, HowStuffWorks, Inc. <http://computer.howstuffworks.com/napster.htm/printable>. Web site accessed on November 7, 2005.
- [5] The Gnutella protocol specification v0.4. Clip2 distributed search services, <http://www.limewire.com/index.jsp/developer>
- [6] I. Clarke, O. Sandberg, B. Wiley, and T.W. Hong. "Freenet: A Distributed Anonymous Information Storage and Retrieval System", Designing Privacy Enhancing Technologies: International Workshop on Design Issues in Anonymity and Unobservability, LNCS, December 2000.
- [7] I. Stoica, R. Morris, D. Karger, M.F. Kaashoek, and H. Balakrishnan. "Chord: A scalable peer-to-peer lookup service for Internet applications." Proceedings of ACM Sigcomm, August 2001.
- [8] Gong, Li, Project JXTA: A Technology Overview, Sun Microsystems, Inc., 25/4/2001.
- [9] Steve Waterhouse, "JXTA Search: Distributed Search for Distributed Networks", Technical Paper, Sun Microsystems, Inc., 2001.
- [10] Ashwin R. Bharambe, Cormac Herley, Venkata N. Padmanabhan, "Analyzing and Improving BitTorrent Performance", Technical Report MSR-TR-2005-03, Microsoft Corporation, February 2005.
- [11] Ryan S, Mike S, Raymond K, Emir B, "The Future of the Decentralized Model of P2P File-Sharing", University of California, San Diego, 2000.
- [12] Gian Chand Sodhy, Fazilah Haron, Tan Tien Ping, Anthony Wong Kee Ling, Wei Hoo Chong, Chan Huah Yong and Rajkumar Buyya, "Design Framework of Compute Power Market for Peer-to-Peer and Grid Environments", Proceedings of The 1st International Workshop on Knowledge Grid and Grid Intelligence (KGGI'2003) (W.K.Cheung and Y.Ye, editors), Halifax, Canada, 13 October 2003.
- [13] Tan Tien Ping, Gian Chand Sodhy, Chan Huah Yong and Rajkumar Buyya, "A Market-based Scheduler for JXTA-based Peer-to-Peer Computing System", Proceedings of International Conference on Computational Science and its Applications (ICCSA 2004), Perugia, Italy, 14-17 May 2004.
- [14] Christoph L, Oliver P, "A Distributed Search Service for Peer-to-Peer File Sharing in Mobile Applications", Proceedings of the Second International Conference on Peer-to-Peer Computing (P2P'02), Germany, 2002.
- [15] Changtao Qu, Wolfgang N, "Exploring JXTAsearch for P2P Learning Resource Discovery".
- [16] Adriana I, Ian F, "On Fully Decentralized Resource Discovery in Grid Environments"
- [17] Maxim Martynov, Boris N, "An Indexing Algorithm for Text Retrieval", Rusia.
- [18] Cameron R D, "Using Mobile Agents for Network Resource Discovery in Peer-to-Peer Networks", Dublin City University.
- [19] Project JXTA, <http://www.jxta.org/>
- [20] S. Osokine, "Search Optimization in the Distributed Networks", 2002.
- [21] JXTA Java™ Standard Edition v2.5: Programmers Guide, Sun Microsystems, Inc, September 10th, 2007.
- [22] Angelos S, Dan R, Sambit S, A Lightweight, "Robust P2P System to Handle Flash Crowds", Technical Report EE200321-1, Columbia University, 2002.