Use of JXTA in Creating a Peer-to-Peer Application:
Instant Merchandise Advertising Application

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ABSTRACT

Most Internet applications use the traditional client/server architecture. In this architecture, clients connect to a server using a specific communication protocol to obtain access to a specific resource. The processing involved in delivering a service usually occurs on the server, leaving the client relatively unburdened. This architecture is common among popular Internet applications, including the World Wide Web, File Transfer Protocol and email. The major drawback to this model is the tremendous burden placed on servers. The Internet is not making use of the full potential of all computers attached to the network.

The Peer-to-Peer approach to communication on the Internet has created a lot of publicity in recent years due to the emergence of popular applications such as MSN Messenger, Napster and ICQ. Sun Microsystems has seen the Peer-to-Peer phenomenon grow. In their attempt to standardize procedures, Project JXTA has emerged.

The purpose of this project is to call attention to the importance of the Peer-to-Peer model and how this model can improve on already existing Internet applications. Distributed computing is a natural extension of the Internet's philosophy of robustness through decentralization. In the following, topics addressed will include: an introduction to Peer-to-Peer architecture; issues involving Peer-to-Peer versus the client/service approach; a brief history of the use of Peer-to-Peer, and, a description of JXTA's approach to solving some issues of the Peer-to-Peer architect.
This project will conclude with the implementation of a Peer-to-Peer application similar to a newsgroup without the use of a central server.

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INTRODUCTION

The importance of Peer-to-Peer (P2P) technology is evident. Any device in a P2P network can provide resources and services to other devices on the network. P2P networks change...
perceived in a network as opposed to the traditional server/client architecture. Numerous benefits are observed when we move away from the client/server approach.

JXTA, a collaborative research project that stands for “Project Juxtapose”, acknowledges the need for P2P computing standards. JXTA peers create a virtual network where any peer can interact directly with other peers and resources. The project boasts about interoperability, platform independence, ubiquity and the ability to traverse firewalls. To gain thorough knowledge of JXTA, I needed to experience working with the standards. As a result of working with the standards for this project, I created the application ‘Ottawa Garage Sale’.

‘Ottawa Garage Sale’ is an application, created in Java, which uses the JXTA library and standards. This application resides on a peer computer in a virtual network where an individual can advertise items for sale. Due to the distributed nature of the program, various design decisions were addressed. The program was complex to implement but it has many benefits over the server/client approach.

Although ‘Ottawa Garage Sale’ is not a completed application ready for mass use, my experience using JXTA proved to be invaluable in helping me to understand the technology. This report will include an examination of design and implementation issues and an analysis of the server/client verses the P2P approach.
INTRODUCTION TO P2P ARCHITECTURE

“Peer-to-peer computing isn't new. As many as 30 years ago, companies were working on architectures that would now be labeled peer-to-peer.”¹ Several factors have contributed to the popularity of the Peer-to-Peer computing - in particular, increased bandwidth and computing

power.

For many years, Peer-to-Peer architecture did not resonate well with IT professionals. They were calling peer-to-peer unsecure, unscalable and unmanageable. But today more than ever, its importance is being recognized. For the purpose of this project, the use of Peer-to-Peer computing will be categorized under one of three uses; supercomputer, content distribution or collaboration. More on each category will follow.

1.1.1 SUPERCOMPUTER

The most impressive uses of peer-to-peer involve reclaiming unused computing resources and tying them together into a virtual supercomputer. Peer-to-Peer computing enables corporations and other organizations to obtain benefits at a fraction of the cost of traditional solutions. Instead of getting an additional 1-GHz CPU on an enterprise server for approximately $15,000, corporations are now investing in additional 1-GHz CPU to a desktop for $600. Each separate peer runs small pieces of an enormous application.

According to Researchers at the University of Wisconsin it has estimated that most companies use less than 25 percent of their computing and storage capacity. Peter Lee, CEO of DataSynapse, who

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2 Breidenbach, Susan. “Feature: Peer-to-peer potential,” July 2001,
provides distributed computing solutions to the financial markets, says that even on the market floors, where you would expect systems to be working overtime, idle processing capacity is over 60 percent.4 “According to the Omni Consulting Group, the average number of unused computing cycles in a company is about 47%, which includes heavily used servers and hosts. When desktops alone are considered, the percentage is much higher.”5

1.1.2 CONTENT DISTRIBUTION AND FILE SHARING

File sharing made Peer-to-Peer computing popular. Programs such as MSN Messenger, Napster and Kazaa generated interest into the Peer-to-Peer trend. Content distribution and file sharing is another way of sharing resources such as storage space. There would be an incredible burden placed on one computer to perform all the tasks that the Kazaa (a file sharing program) Peer-to-Peer network performs. In a server/client system, searches would be time-consuming, download times would be lengthy and reliability would be uncertain.

To perform a search for a file in a client/server computing environment, similar to the number of files found on Kazaa, would entail a search of millions of records by one server. This is in comparison to

5 Breidenbach, Susan. “Feature: Peer-to-peer potential,” July 2001,
thousands of computers in a virtual network performing searches on considerably smaller number of records. On the virtual network, searches for titles literally take seconds.

Beyond efficient search speeds, a file sharing system using distributed computing offers the advantage of having a large file space. The server/client method suffers from having one point of failure which is the main server.

1.1.3 COLLABORATION

Decisions are better when they are made together in groups. There is a need for collaboration among dispersed people on distributed systems. The Web is transforming into a much more custom-made environment where you can share information on your own terms. Collaboration means that groups have access to the latest data.

Collaboration increases productivity by increasing the timeliness of getting the latest information. Peer-to-Peer computing allows teams in different geographic areas to work together. As with file sharing, it can decrease server storage needs by storing pieces of a larger project on distributed computers.

1.2 IMPORTANCE OF PEER-TO-PEER COMPUTING

The importance of Peer-to-Peer computing is apparent for both consumers and businesses alike. At any given time, all computers in a network fail to use all resources and much of computing activities are duplicated. Distributive computing makes use of unclaimed resources and attempts to reduce redundancy. The distributed model can aide in bettering content sharing, computer power, and collaboration for consumer and businesses.

1.2.1 PEER-TO-PEER COMPUTING IN BUSINESSES

Merger efforts in most companies today are being driven by the need to automate business processes. The centralized architecture is not well-matched to meet the demands of what is a distribution problem. The failure to create architectures, one that reflects corporate structure, will result in a loss of efficiency and increased costs for companies.

Any major company observed today will have a number of computers on a network typically operating at only a small percentage of its capacity. The potential for creating a supercomputer exits. Rather
than incurring costs of purchasing expensive server resources, an additional relatively inexpensive workstation could be purchased. Pressures have been placed on computers to deploy solutions faster and more cost-efficiently.

Many business operations that are performed today in a centralized approach can be modified to use the decentralized approach more efficiently and at a lower cost to the company. Email can be sent directly from one peer to another peer thereby virtually eliminating the cost of storing email letters on expensive server hard drives. Pieces of a larger project can be stored on different peers and therefore reduce the need for server memory.

The greatest of all advantages to integrating a company in a distributed approach is increased collaboration. Having the freshest information for all stakeholders of a project is invaluable. Less time is spent on gathering the latest information. Stakeholders can make more timely and informed decisions.

Intel can be a model for the Peer-to-Peer in the workplace. “Intel engineers have used internal p-to-p technology Netbatch in chip design and have saved Intel $500 million over a decade.”\(^6\) One can only predict how the benefits of collaboration factor into the equation.

1.2.2 PEER-TO-PEER COMPUTING FOR CONSUMERS

The potential of Peer-to-Peer computing will become increasingly apparent as the model matures as it leads to new types of services and applications. The Internet is distributed and free from any one central entity or control. The result is the emergence of applications that are becoming increasingly free from central control. A Peer-to-Peer application is inherently immune to attack, manipulation and control. This does not limit or restrict our freedom to freely communicate across cultural, political, social and religious boundaries. A peer in a network is both a producer as well as a consumer of information.

The main uses apply to businesses as they do to consumers. The underlining theme of increasing computing power, files sharing and collaboration remains the same. Further developing this technology is a worthy endeavor.

2 CLIENT/SERVER VERSES PEER-TO-PEER

This paper would be incomplete without discussing the strengths and weaknesses of both the client/server approach and the Peer-to-Peer approach. Although decentralization offers many advantages, recognizing the importance of client/server approach is important.

2.1 SECURITY
Careful measures for security must always be considered when creating any application that communicates messages over the Internet. Messages that are communicated over the Internet have to deal with confidentiality, integrity and non-repudiation. Peer-to-Peer applications have a greater restriction placed upon it.

Similar to the client/server approach, Peer-to-Peer computing deals with the issue of confidentiality, integrity and non-repudiation. The difference is in the way that Peer-to-Peer applications use a hybrid approach to solve anonymity. It is rare today to encounter pure Peer-to-Peer applications for this reason. Once identification of a peer is established, secret keys, signatures, certificates and encryption can be used to duplicate the same level of security as an application that uses the client/server approach.

### 2.2 FIREWALLS

Most Peer-to-Peer software can be manipulated to create and slip through holes in the security architecture of a network. For example, AOL Instant Messenger can allow you to "sniff" for open ports on a peer machine and Gnutella has instructions on their Web site that will allow a user to bypass the port rules on a firewall. As a peer takes on services, they are open to the same attacks as servers.

### 2.3 RELIABILITY
The probability of the entire Internet ever being down is small to nil. This is due to the structure of decentralization that the Internet takes. There are not one or a few points of failure. The same is true with a Peer-to-Peer application. Peer-to-Peer applications follow the decentralized approach.

3 CREATING A PEER-TO-PEER APPLICATION

In understanding Peer-to-Peer computing, I felt that I needed to create an application that incorporates a Peer-to-Peer aspect to it. I felt that I needed to put all my theory into practice to better understand concepts that were described. Working with the concepts gave me a much greater understanding of the ideas behind the Peer-to-Peer architecture.

In creating a Peer-to-Peer application, I choose to use the JXTA standards in Java since JXTA appears to have a promising future.

3.1 WHAT IS JXTA?

Peer-to-Peer computing has long been envisioned in an increasingly connected and mobile population. Spearheaded by Sun Microsystems, JXTA is a collaboration research project for P2P computing. Sun Microsystems recognize the usefulness for client and web-based computing; however, a strong need exists for Peer-to-Peer computing standards.
JXTA is a set of protocols that can be implemented in any language that allows distributed client understanding. It provides a platform to perform the lowest level of functionality required by Peer-to-Peer applications. JXTA is based on functionality of peer discovery and peer communication. JXTA defines a set of common protocols that enables Peer-to-Peer computing.

3.2 CONCEPT BEHIND THE APPLICATION

Think for a minute of all the items in your possession that are of no use to you that could create possible revenue. With the click of a button, imagine advertising those items to thousands of people. Current systems similar to the one I have just described exist using the client/server architect via the internet. Client/server architecture fails to be a perfect solution for advertising these items due to the high cost of purchasing and maintaining servers. The costs associated with servers used to advertise come with a cost to sellers and buyers.

With the use of Peer-to-Peer computing over the Internet, peers can communicate directly without the presence of a server.

3.3 BENEFITS USING PEER-TO-PEER ARCHITECTURE

Similar systems exist using the traditional client/server approach. Namely eBay and AutoTrader.ca use a central server to store all items for sale. Latest information, increase response times and absent of central
server are reason to attempt a decentralized model.

3.3.1 ABSENCE OF A CENTRAL SERVER

There are benefits to having architecture, such as scalability, which doesn’t use a central server. As the number of items being advertised grows, the system is not overburdened. There is never a need to upgrade or maintain hardware. Furthermore, there is greater reliability. There are no additional costs and no fee is levied on suppliers and consumers for advertising and purchasing items. By peers connecting directly with each other, the system benefits from content distribution.

3.3.2 LATEST INFORMATION

Users of the new system will be presented with the latest and freshest information. Theatrically, an item could be advertised and sold within minutes.

3.3.3 INCREASED SEARCH RESPONSE TIMES

The duty of searching for items on a client/server approach can cause much burden to the server. The Peer-to-Peer approach attempts to increase response times by perform searches on individual machines before returning results to the peer requesting information. The job of searching is performed by all peers in a virtual network rather than a single server resulting in quicker response times. Every computer in the
network is sharing the workload.

3.4 IMPLEMENTATION

GarageSale is a standalone program that resides on a peer’s computer. Upon starting GarageSale, JXTA works behind the scenes to create services that will aide in creating a decentralized system of advertising items for sale between peers in a network. The following will show how GarageSale uses JXTA services of peergroups, advertisements and pipes.

3.4.1 PEERGROUPS

Upon initiating GarageSale, JXTA works surreptitiously to establish a virtual network connection to the World Peergroup, which is the default peergroup. Once a connection is made, a peer will connect to a user peergroup - namely OttawaGarageSaleNet. In this peergroup, there is a separate set of customized services used for the GarageSale application. All communication between peers using the GarageSale application will be within the OttawaGarageSaleNet peergroup.

3.4.2 ADVERTISEMENTS

Advertisements help peers discover any type of service, including peergroups, other peers and pipes. The GarageSale application uses three advertisements. GarageSale makes use of all three types of
advertisements. Before a peer can join the OttawaGarageSaleNet peergroup, a peer must discover the advertisement of this peergroup in the World Peergroup. If the advertisement does not exist, then a peer must create the peergroup advertisement. Upon entering the OttawaGarageSaleNet group, a peer must create advertisements of its own existence and of its pipe. Pipes will be described in the next subsection.

3.4.3 PIPES

One of the most powerful of JXTA’s services is the pipe service. A pipe is a logical abstraction of an address on a network transport that is capable of sending and receiving network messages. Pipes in this application will be used to communicate information about the items for sale in the virtual network.

3.4.4 GARAGE SALE IN A NUTSHELL

Much like the popular series of books by O’Reilly attempts to do, here is a brief summarization of what GarageSale is all about.

The application GarageSale manages a peer’s inventory of items for sale and establishes the means for searching for other items for sale over the virtual network. Every peer advertises itself and its pipe. Through advertising, peers are aware of all the other peers on the OttawaGarageSaleNet peergroup.

Three protocols were created beyond the services that JXTA
already offered. The first is the ‘search’ protocol. The ‘search’ protocol sends a category to all the peers in the network. After each peer searches its own inventory, the result is returned to the inquiring peer. A second protocol is used to view a particular picture from a peer. A message is sent to the peer for the picture and the picture is communicated back the inquiring peer via the pipe. Lastly a ‘talking’ protocol exists. GarageSale has a chat area where peers can communicate. A text message can be sent to all peers in the group via the ‘talking’ protocol.

For source code and executable of this application please go to: www.xentrixsolutions.com/GarageSale .
CONCLUSION

Furthering Peer-to-Peer computing is a worthy endeavour deserving much attention. The benefit of collaboration, file sharing and capturing the potential of all computers on a network cannot be overlooked. Peer-to-Peer has a promising future and we have only begun to see its potential. JXTA is taking a step in the right direction in creating standards.

By creating a Peer-to-Peer program, I’ve come to realize the power of distributive computing. I was able to create a virtual network without the use of a pricey server. With a little more effort in revising the implementation of the GarageSale program, I believe that it would out benefit any comprisable solution using a server. Learning Peer-to-Peer was difficult but was worth while.

A suggestion I would bestow onto anyone learning the Peer-to-Peer paradigm would be to purchase a book that focuses on theory and implementation. Most notably I would recommend JXTA by Brennon Walsh. Without the use of a strong reference, the concepts may appear difficult.

I see the future of JXTA being a higher level of abstraction. Many commands are lower level and redundant. JXTA would benefit from a
higher level of abstraction making it more comprehensible to a wider range of programmers.

Bibliography


