Future Research Challenges of Peer-to-Peer Systems

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***Abstract*—** PCs have become much more powerful, and they are able to handle the data processing locally rather than on central servers. Because of this, peer-to-peer computing can now occur when individual computers bypass central servers to connect and collaborate directly with each other. In this paper briefly discussed the ability to exploit unused resources (storage, processing) in the host computers, scalability to support large numbers of clients and hosts with load balancing of network links and host computer resources. This paper summarizes the current state of the research effort in the field of peer-to-peer (P2P) networking. Also focused some major trends in the research effort of the peer-to-peer community are explored.

***Keywords*—** p2p trends, p2p technology, p2p models, p2p future challenges.

I. INTRODUCTION

If one was considering recent technological advances based on the impact which this technology had during the time since its introduction, the concept of peer-to-peer (P2P) networking would most certainly be among the top contenders for highest impact in shortest time. The field is driven by a huge demand which at the time of writing of this paper still cannot be satisfied by other means or technologies: The user of the modern Internet, being aware of the resources that are available at other users' systems, would like to share these resources with a minimal overhead and without third parties being involved in the process [1].

Peer-to-peer networking is the technology that has the most potential to satisfy this demand. The story is clear: The Internet was designed with peer-to-peer applications in mind, but as it has grown the network has become more asymmetric. What can we do to permit new peer-to-peer applications to flourish while respecting the pressures that have shaped the Internet to date?

Current peer-to-peer applications generally would benefit from an Internet more like the original network, where these restrictions were not in place. How can we enable peer-to-peer applications to work better with the current technological situation? Peer-to-peer applications stress the bandwidth usage of the current Internet. First, they break the assumption of asymmetry upon which today's ADSL and cable modem providers rely. There is no simple way that peer-to-peer applications can work around this problem; we simply must encourage broadband connections to catch up [1].

However, peer-to-peer applications can do several things to use the existing bandwidth more efficiently. First, data caching is a natural optimization for any peer-to-peer application that is transmitting bulk data; it would be a significant advance to make sure that a program does not have to retransmit or resend data to another host. Caching is a well understood technology: distributed caches like Squid have worked out many of the consistency and load sharing issues that peer-to-peer applications face [1].

Second, a peer-to-peer application must have effective means for allowing users to control the bandwidth the application uses. If I run a Gnutella node at home, I want to specify that it can use only 50% of my bandwidth. Current operating systems and programming libraries do not provide good tools for this kind of limitation, but as peer-to-peer applications start demanding more network resources from hosts, users will need tools to control that resource usage [1].

II. P2P TECHNOLOGY

The technical side of the concept of peer-to-peer networking has evolved rapidly during recent years, always driven by the applications that the new network should be able to support. Contrary to the development of the traditional Internet, that first emphasized a set of generalized building blocks and then used these to implement

applications, the application has always been the main focus in the realm of peer-to-peer networks and only recently generalized concepts began to emerge from the various implementations [2].

The fundamental idea to directly share resources that are located on end users' computers on the border of the Internet has remained unchanged. However, the implementations thereof differ greatly: Beginning with Napster's [Napster] centralized management of which resources are available and only leaving the sharing of the resources itself up to the users, the trend has since been to pull these management and discovery operations into the peer-to-peer network itself. This goal has been achieved with various levels of success in diff-errant implementations and still is to be regarded as ongoing work and research [2].

The two main technical difficulties are cohesion and scalability: On one side, it is usually desirable for a peer-to-peer network to be a connected, single, and searchable network, rather than being split into several disconnected networks over time. All resources of all nodes in

The network should be equally discoverable and accessible to all other nodes in the network. On the other side, the cost and communication overhead to ensure this first point needs to be manageable and not must not displace the primary focus of the peer-to-peer network {the sharing of resources. Secondary technical challenges are those of establishing accountability, trust, and yet anonymity between users, improving the speed and success rates of resource discovery procedures, and to develop generalized tools, libraries and protocols that are independent of one specific implementation of a peer-to-peer network.

III. Peer-to-peer Models

There are three distinct peer-to-peer computing models:

A. Multiple Peer Relationship

PCs are connected/networked to each other through servers, and files can be shared and collected from anyone else on that same network. One key problem is this can lead to major breeches in security and intellectual property issues [3,4].

Examples:

Napster and its Legacy (music sharing)

- Provided a means for users to share music files primarily MP3s.
- Launched 1999 – several million users.
- Not fully peer-to-peer since it used central servers to maintain lists of connected systems and the files they provided, while actual transactions were conducted directly between machines.
- Proved feasibility of a service using hardware and and data owned by ordinary Internet users.

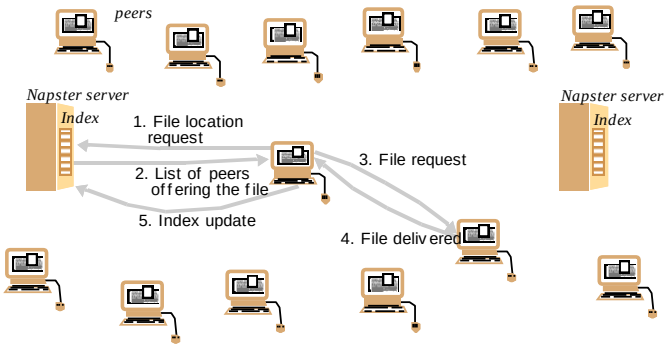

Fig. 1 Napster and its Legacy

B. Distributed Peer Relationship

A group of computers connected together to combine their computing and processing abilities to search the Internet or solve very complex problems requiring massive process crunching [3,4]

Examples:

Infrasearch- (search engine)

Entropia - (climate simulations and astrological calculations)

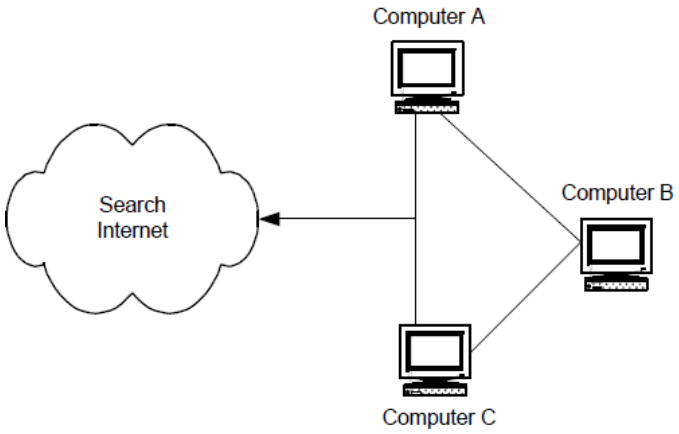

Fig. 1 Search Engine

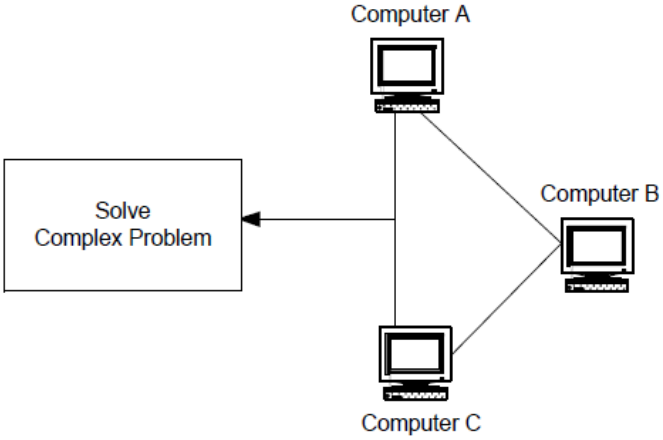

Fig. 3 Entropia Simulation and Calculations

C. Collaborative Peer Relationship

A small group of people agree to collaborate through a common interface, such as on-line gaming, chat rooms, instant messaging, or e-learning environment [3].

Examples:

Jeopardy - (on-line gaming)

Chat Here - (chat room)

Horizon Live- (e-learning seminars)

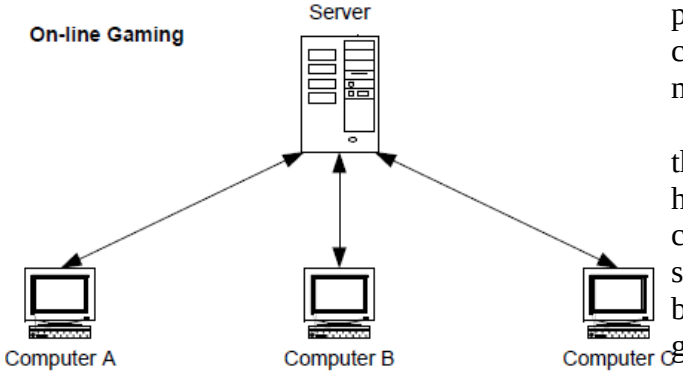

Fig.4 On-line Gaming

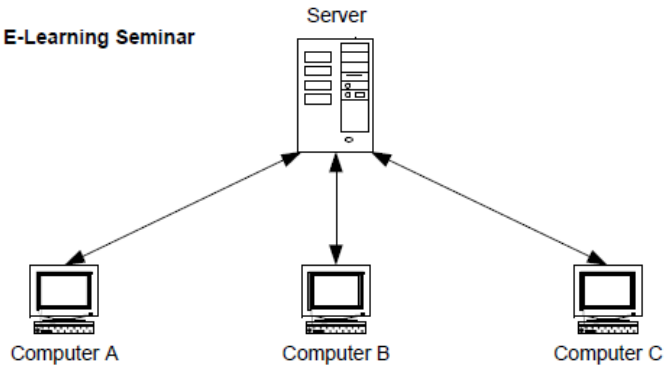

Fig.5 E-Learning

IV. Significance and Impact of Peer-to-Peer Computing

So what is the significance of peer-to-peer computing? It changes the way people interact in the areas of information sharing, collaboration, and learning. First, peer-to-peer computing changes the way people share information. Prior to the Internet and even the pervasive use of PCs, information was mostly disseminated through television, radio, or via written (not digital) correspondence. But now information is digitized via e-mail, electronic documents/files, or web pages and can be distributed to many different people in a short period of time. The format of information has also greatly changed and ranges from short, sloppy, opinionated text to lengthy, well organized, and thoroughly researched documents. People now have to "filter" through a lot of junk data to get to the information they may be seeking. This becomes even a greater challenge when people now have access to so many other computer systems and consequently, the masses of information on those systems.

Second, peer-to-peer computing changes the way people collaborate. People no longer have to be in the same room to plan a project, conduct a workshop, or learn a computer software program. Ideas and discussions can be captured electronically and distributed to groups of people in separate locations for review and input. But in order for this to be effective, people have to learn the technical tools in order to communicate and collaborate (such as using an electronic whiteboard or a video conferencing system)

and must learn to express themselves in different ways.

Lastly, peer-to-peer computing changes the way people learn. Traditional classroom environments are no longer the only way to facilitate effective learning. Well-designed media-rich web content can be a very effective learning format and can cover the primary ways people learn by incorporating sound, text/visual queues, combined with hands-on exercises and examples. What is different, however, is that the learner has to become more responsible for their learning. Traditional training "pushes" information to the learner and puts the onus of learning more on the instructor. Whereas virtual training requires the learner to "pull" out the information he/she is seeking, thus shifting the onus of learning onto the learner.

V. Using Peer-to-Peer for E-Learning

Currently, peer-to-peer computing and e-learning are being combined and used by businesses, academic institutions, and by individuals. For example, businesses are conducting new-hire orientation via their intranets, and new-hires can interact with each other during the training. Students can do research together or view draft documents and mark-ups real time, then electronically submit their final project to their teacher for grading. Individuals are sharing their knowledge and experiences with others through chat rooms and on-line support groups. The prospects for e-learning in formal or informal virtual settings are tremendous and as long as people want to share information, there is an opportunity to learn. Most experts in the peer-to-peer and e-learning industries agree that there is a great deal of hype and many companies are at the trial stage of bringing these two areas together to produce effective results. Peer-to-peer computing and e-learning involves a change of paradigm or a change in how people deal with knowledge and information. Because it's a paradigm change, it is uncomfortable and the outcome is somewhat unpredictable [5].

VI. Future Trends and Challenges

Peer-to-peer computing "represents a swing of the pendulum back toward user control" (Shirky, Clay – see Reference). Powerful PCs and the Internet enable people to come together through a common environment. More and more people are taking information sharing into their own hands, and companies are finding themselves in a situation of trying to control people and influence the use of the Internet. Specific examples of future trends and challenges include [6]:

- Record Companies: Creating a "copy protected media" format for music files designed to prevent.
- People from sharing illegal copies of music files.
- Corporations: Increasing network security levels on corporate networks due to employees granting unauthorized users access to their PC to enable file sharing.
- Education Organizations: Shifting the learning environment from traditional classrooms to virtual.
- Classrooms and developing/implementing effective peer-to-peer learning opportunities.

A. *P2P vision for the future*

No More Dedicated Servers. Everything in Internet Served by Peers. No mail servers, no file servers, no web servers. Individual peers, operating independently from one another offer all the basic services. File sharing was first P2P application. P2P extending beyond file sharing [7].

B. *Global P2P Network*

Besides file sharing, "Skype", and research prototypes.

C. *Ubiquitous computing*

Small, autonomous devices collaborating.

D. *Other Trends*

High bandwidth residential and wireless access.

Online gaming (50% of network traffic!) main source of traffic. File sharing moved to pay models. Online communities gaining importance.

VII. CONCLUSIONS

The field of peer-to-peer networking has seen fast-paced developments in recent years. Peer-to-peer computing is becoming more and more prevalent as people are using their own PCs to bypass central servers to connect directly with each other. This is changing the way people share information,
collaborate, and how they learn. However, because peer-to-peer computing gives tremendous control to the individual, the outcome is somewhat unpredictable. The future of peer-to-peer computing is being formed as we speak, so hang on for the ride! Being aware of this, the author hopes that this paper may be useful for wetting the appetite of other students and promote the research interest in peer-to-peer networking.

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