

Peer-to-Peer Networking: Explanations, Applications, and Implications  
Austin Halliday, Lubbock Christian University  
Faculty Advisor: Joe Marshall, Lubbock Christian University

## **ABSTRACT**

Peer-to-Peer networks have been in existence since before the turn of the millennium. These networks exist in several types: file sharing, telephony, or VoIP, media streaming, and discussion forums. Each type serves a distinct role and can be utilized in both positive and negative fashions. This brief paper seeks to describe in overview the various types of Peer-to-Peer networks, how they operate, and some of the obstacles encountered. The paper is written with education in mind and details some of the possible ways that Peer-to-Peer networking can be used to enhance educational experiences.

## **INTRODUCTION**

Peer-to-Peer networks are often thought of in terms of file sharing networks that distribute illegal copies of copyrighted material. However, this is not the case; Peer-to-Peer networks also include telephony, or Voice over IP, networks, media streaming networks, and discussion forums<sup>1</sup>. The paper will also include a brief section concerning Instant Messaging. File sharing has raised a great deal of controversy concerning the legality of some Peer-to-Peer network activities. Despite this, more and more Peer-to-Peer networking appears each day, many of which have proven beneficial. Telephony networks have allowed peers in businesses and institutions to stay in constant contact even over great distances, reducing the loss in productivity due to travel and time constraints. Media streaming allows teachers and other educators to produce supplementary materials that can be accessed at the convenience of the user without having to wait extended periods for files to completely download, as experienced with file sharing networks. Discussion forums are not often classified as Peer-to-Peer networks though they are the perfect example of peers getting in touch with one another and teaching one another in conjunction with interaction and instruction from administrators and instructors. Peer-to-Peer networks have a great deal of potential and require a detailed look to decide which type or types of networks are appropriate for a given circumstance.

## **FILE SHARING**

File Sharing exists in two fashions, a client-to-server relationship and a Peer-to-Peer relationship. In the case of a client-to-server the files are stored on a central system and a client sends a request to the system looking for specific files. The server then locates appropriate files, lists them for review by the client and queues for transmission those that are selected. In a Peer-to-Peer network the relation of client-to-server is completely done away with and all users are viewed as equal “peers”.<sup>2</sup>

Within Peer-to-Peer file sharing networks there exist two distinct types. The first of these types is a “pure” peer-to-peer network and the second is a “hybrid” Peer-to-Peer network. A “pure” peer-to-peer file sharing network does not have a centralized system providing the service; requests from a peer go directly to other peers and the results of

those requests are served back by the peers that respond to the request. A “hybrid” Peer-to-Peer network utilizes a centralized system to provide its “peers” access to one another.

“Pure” Peer-to-Peer networking does not rely on a central server or central router; peers are equal and act as server and client. In the case of “pure” Peer-to-Peer networks a user would send out a request through the software enabling the network and would receive returns from any “node” that had an appropriate response, each “node” being the computer of another user on the network. The searcher, after receiving a response from a “node,” would then request the file and a download would be queued. Then the request for the file would travel back to the “node” on the same route that the original request traveled. This protocol proved inefficient and was revised later to allow traffic between peers to travel more directly.

“Hybrid” Peer-to-Peer file sharing networks are the type more commonly thought of when discussing Peer-to-Peer networks. In a “hybrid” network the files are hosted by peers, but the requests for those files are handled by a central server. The central server does not house the resources directly, rather it is informed by users what resources they have and which resources they wish to make available to their “peers.” Some famous examples of “hybrid” file sharing Peer-to-Peer networks include Kazaa, Napster, and Bit Torrent.

Kazaa, during its heyday, was a file sharing network that allowed peers to search for files housed on the computers of other peers. Once the desired files were located they were queued for download and transferred to the requestor’s computer. Problems arise with file sharing networks like Kazaa when users are transferring copyrighted and illicit material. Most readers will recall the numerous suits both inside and outside of the United States several years back when music industries world wide came to bear against Kazaa. The total dollar amount of settlements paid out by Kazaa and the owners of its network is not a matter of public record though it had to be over 100 million dollars as that was the amount specified in a settlement to Sony BMG, Universal Music, EMI, and Warner Music.<sup>3,4</sup>

Napster was the first Peer-to-Peer file sharing network to reach the massive level of fame now commonly attributed to itself, Kazaa, BearShare, and various other Peer-to-Peer file sharing networks. Though Napster still exists it is very different from when it began. Napster started as a decentralized Peer-to-Peer network that allowed users to share and download music from one another. The legal repercussions of Napster’s illegal activity were the topic of much debate. While big name groups such as Metallica and Madonna suffered loss of income, other, underground groups were able to establish a fan-base and increase sales because of users downloading their music.<sup>5</sup>

Bit Torrent is currently being utilized as a file sharing Peer-to-Peer network across the internet. Bram Cohen designed the first release of Bit Torrent and implemented it in 2001. Bit Torrent takes a file that is uploaded by a “seeder” and splits it into many pieces among the nodes of the network. When a request is made for the file in question a series of requests are sent to each node that houses the particular file. This method of download has advantages and disadvantages in comparison with standard HTTP downloads. Bit Torrent files are not stored in any one location and thus are less susceptible to outages and overloads that are common in centralized HTTP download networks. However, because of the time associated with establishing all of the peer connections, a Bit Torrent download can take a significant amount of time to reach full

speed and may slow down toward the end of a download. Furthermore, streaming downloads are currently uncommon on Bit Torrent downloads because of the order that pieces of a file are downloaded. To ensure availability the rarest files or file pieces are downloaded first, this non-standard order makes it impossible for a recipient's computer to begin playback of a file prior to download completion.<sup>6</sup>

Virtually all file sharing Peer-to-Peer networks have allowed for the passing of illegal copies of material, especially music. As such, file sharing networks are often prosecuted for their illicit actions. The difficulty in prosecuting "pure" Peer-to-Peer networks arises with the lack of a centralized system. Without the centralized or semi-centralized network that exists in a "hybrid" Peer-to-Peer network it is difficult to even know who the peers are within the network, much less what files they have available. There is a great deal of potential for productivity and information sharing inherent in file sharing networks, but until these networks become reliable and legal that potential will remain unrealized.

### **TELEPHONY - VoIP**

Telephony is synonymous with Voice over IP (VoIP). VoIP networks allow for a reduction in cost and an increase in productivity by condensing a number of services into a single network that can be accessed by peers. These VoIP networks typically fit the definition for a "hybrid" Peer-to-Peer network. The information carried across a VoIP network can range from simple voice conversations all the way to full fledged multimedia presentations that include streaming video. These networks are especially versatile as they can function within an entity's local network, across the Internet, and, in some cases of lower functionality requirements, across standard public phone systems.

The facilitation of communication provided by VoIP is useful in the business and academic worlds. An example of such a network is Skype, a program created by some of the staff from the Kazaa project. Skype is currently owned by eBay and can be used to make calls from one PC to another at no cost. The program consists of two parts: SkypeIn which allows for incoming calls and SkypeOut which provides for making calls through the service. The beauty of Skype lies in its Peer-to-Peer construction. The topmost layer of Skype is the login server which validates the credentials of a user and gives them access to the nodes and super nodes within the network. A user with a sufficiently powerful machine and connection can become a super node which functions by routing traffic within the Skype network. Routing through nodes and super nodes allows Skype to function around firewalls and connect to its many thousands of users. In effect the service manipulates traffic to avoid traditional blocking problems by routing the majority of the traffic through nodes that do not block the service. Though the software is not always successful many typical problems with network traffic are avoided. As with file sharing networks, discussed in earlier sections, each user is considered a node and can be called upon or submit requests to contact other users.<sup>7</sup> The bottommost layer of the Skype program is the connection between two users. Once the users have logged in and located one another the connection is established and the purpose of Skype is accomplished.

The overall effect of VoIP networks can be seen throughout the business world in its facilitation of constant communication. In the academic world the potential of VoIP is only just being realized. A study conducted between two Texas-based

colleges showed a definite increase in learning based on multiple tests using Skype. Students were shown to expect immediate help with problems and the VoIP application allowed fellow students and instructors to connect verbally with their peers in order to provide that help in a form that made the recipient feel as though they had been recognized and appreciated.

With campuses becoming dependent upon one another and branching out across broad geographical distances the importance of instant, constant communication will only increase. Voice over IP networks allow for that communication and foster more personal interaction while improving productivity. Universities and businesses that fail to recognize this trend in communication may find themselves unable to support their ever growing size and population and suffer a decline in productivity and learning potential.<sup>8,9</sup>

## **MEDIA STREAMING**

Media streaming is a term used to describe a number of protocols that utilize networks, especially the Internet, to transmit data to a client in a “progressive playback” form. This means that the client does not have to wait for the entire file to download before they begin to watch or listen to its contents. YouTube and Yahoo! Music are common examples of streaming media. The file begins transmission from the server to the client and loads into a buffer, as the buffer fills the file will begin playback and theoretically the buffer will always stay ahead of the current playback point.<sup>10</sup> Buffers have proven very advantageous for users as they reduce the impact of network connection congestion and interruption.

Technology education has seen a trend toward modular classes. Modular classes are similar to modular buildings. The basic structure of the class is created before the class begins. After the class begins the modular design allows for changes in implementation such as adding and removing lessons as well as adjusting the overall difficulty of the course according to the students needs. Streaming media has proven to be a useful supplement to modular classes as it allows the teacher to create or capture presentations that can be accessed by students at any time. An example of such utilization would be a teacher video taping a lecture. The teacher then takes that recording and uploads it to a school or commercial web server in conjunction with narrated power points and other materials. When the student begins their homework they would be able to access the lecture and other materials almost instantly from the comfort of their own computer chair and digest the information at their own pace. Streaming media is also being utilized in a number of self-teaching modules ranging from middle school to college level classes. Fortunately for educators, there are free software solutions for creating streaming media packages, Microsoft’s Media Encoder and Real Network’s Helix.

The media streaming discussed thus far concerns networks that fall into the “hybrid” Peer-to-Peer category. There are two types of distribution involved with media streaming. In one case the files are stored centrally and accessed by peers from that centralized system. The downside to such a system is an increase in congestion on the network. While streaming eliminates a great deal of the congestion inherent in networks and the Internet, it can be affected by too many connections and cause the playback speed to exceed the buffer speed. Possible solutions to this problem lead to a less centralized “hybrid” Peer-to-Peer network where the files are housed on peer computers and

requested by other peers through a system that tracks what files are available and where they are stored, similar to the application Kazaa. Unfortunately the increase in accessibility leads to some of the legal complications encountered by Peer-to-Peer file sharing.

## **DISCUSSION FORUMS**

Discussion forums are one of the most commonly used Peer-to-Peer networks concerning topics of all descriptions. In a discussion forum peers are connected via a web based application that allows them to make posts in a thread based or chronologically ordered format. Thread based topics are organized under headings that denote their content and users make posts in response to the general topic as well as the posts of their peers within the forum. Chronologically based forums typically stick with a single broad topic and lump all of the posts together organized by their date and time of submission.<sup>11</sup> The overall goals of discussion forums include increasing peer interaction and providing more sources than just the instructor for learning.

As well as being one of the most commonly used forms of Peer-to-Peer networking discussion forums can be one of the most useful. Structure is an important aspect to consider when discussing the utilization of discussion forums for educational purposes. A constructive argument style attempts to focus peers are responding to one another's posts in a thread based forum in order to provide a support community in which peers educate one another with promptings from the forum administrator(s), typically the class instructor. While the structured approach leads to knowledge building a less structured approach can lead to higher learning as it allows for greater creativity and discussion than the responsive style of constructive arguments.<sup>12</sup>

Discussion forums are rapidly becoming an integral part of courses in post-secondary education and have long been a standard in correspondence courses, such as those offered by the University of Phoenix Online. As with streaming media, discussion forums are a resource available to users at their convenience and can greatly enhance the potential of a course. In many cases a forum, especially those that have a set of users that regularly post, generates a community that continues beyond the original scope of the forum. This continued interaction serves the ideal of a continuing education well beyond the constraints of any one course.

## **INSTANT MESSAGING**

A common application of Peer-to-Peer networking appears in the form of Instant Messaging. Instant Messaging, IM for short, first appeared in the 1970's between users of the same machine. As connectivity grew so did IM's, first to users connected to a specific network then to users across the internet during the 1980's and 90's. Instant Messaging shares the "pure" and "hybrid" designs of other Peer-to-Peer networks. In a "pure" IM network peers utilize a protocol to connect directly to one another. This type of IM connection is less common than the "hybrid" form. "Hybrid" IM networks require users to connect to a centralized server and that server creates the connection between them. Examples of "hybrid" IM networks include AOL Instant Messenger (AIM), IRC, and Windows Instant Messenger.<sup>13</sup>

On top of basic communication some Instant Messengers, such as AIM, allow for other types of Peer-to-Peer networks to be established. Various protocols within the

networks allow for file sharing and VoIP. Although Instant Messengers do not generally include Discussion Forums they do embody the major applications of Peer-to-Peer networks.

## CONCLUSION

Peer-to-Peer networks have a great deal of potential and as such must be respected. Awareness of the capabilities of a Peer-to-Peer network is only part of the equation. Educators must be aware of the dangers associated with Peer-to-Peer networks, whether it is illegal file sharing or discussion forums that allow verbal abuse. Through knowledge of potential and careful administration Peer-to-Peer networks can be a great tool for the furtherance of education both within and without businesses and institutions.

## REFERENCES

1. Wikipedia, Peer-to-Peer, [http://en.wikipedia.org/wiki/Peer-to-peer#Applications\\_of\\_peer-to-peer\\_networks](http://en.wikipedia.org/wiki/Peer-to-peer#Applications_of_peer-to-peer_networks), November 12, 2007.
2. Wikipedia, File sharing, [http://en.wikipedia.org/wiki/File\\_sharing](http://en.wikipedia.org/wiki/File_sharing), November 17, 2007.
3. Weihs, J., An interesting court decision, *Technicalities*, 24, (20), 5-7, 2004.
4. The new Napsters, *Fortune*, 146, (3), 115-116, 2002.
5. Saroiu, S., Gummadi, K. P., Gribble, S.D., Measuring and analyzing the characteristics of Napster and Gnutella hosts, *Multimedia Systems*, 9, (2), 170-184, 2003.
6. Wikipedia, Bit Torrent, [http://en.wikipedia.org/wiki/Bit\\_torrent](http://en.wikipedia.org/wiki/Bit_torrent), November 24, 2007.
7. Pan, C.C., Sullivan, M., Promoting synchronous interaction in an eLearning environment, *T.H.E. Journal*, 33, (2), 27-30, 2005.
8. Flatland, J., Integrating voice into the school network: Benefits of Wireless VoIP, *T.H.E. Journal*, 32, (8), 26-28, 2005.
9. Young, D., VoIP in a campus environment, *T.H.E. Journal*, 32, (8), 30-32, 2005.
10. Deal, W.F., The technology teacher's toolbox: streaming media, *The Technology Teacher*, 62, (8), 18-21, 2003.
11. Wikipedia, Internet forum, [http://en.wikipedia.org/wiki/Discussion\\_forums](http://en.wikipedia.org/wiki/Discussion_forums), November 17, 2007.
12. Moore, J.L., Marra, R.M., A comparative analysis of online discussion participation protocols, *Journal of Research on technology in education*, 38, (2), 191-212, 2005.
13. Wikipedia, Instant Messaging, [http://en.wikipedia.org/wiki/Instant\\_messaging](http://en.wikipedia.org/wiki/Instant_messaging), November 24, 2007.