Peer-to-Peer ≠ Piracy

Abstract

Peer-to-Peer(P2P) is one of the most popular Internet technologies today. Because of its extraordinary user experience, people are using it to distribute electronic content. However, a large portion of the content delivered by P2P is pirated and hence the problem whether P2P is only useful for piracy or not arises. In this paper, I investigate the issue of P2P and piracy and argue that it is unreasonable to believe that P2P has little to zero legitimate use albeit P2P could facilitate the diffusion of pirated content (not the action of piracy) for the following four reasons. First, people are actually misled by the current situation of P2P piracy and some anti-piracy organizations into thinking P2P is piracy. Second, P2P is widely used in legal content distribution. Third, P2P even with piracy usually leads to innovative and legal business models. Finally, P2P is in fact the killer of piracy. P2P, therefore, is not piracy.

1. Introduction

Wikipedia[43] defines Peer-to-Peer(P2P) as "a type of computer network that uses diverse connectivity between participants(peers) in a network and the cumulative bandwidth of network participants rather than conventional centralized resources where a relatively low number of servers provide the core value to a service or application". This definition shows the greatest advantage of P2P, which is the cooperation among all participating peers.

Peer collaboration makes P2P very suitable for applications which require resource sharing. There are two main types of resource sharing. One is that peers can share their computing power like CPU cycles with each other. A P2P computing network consisting of millions of PCs could be much more powerful than the current fastest supercomputer. SETI@HOME[33] is a good example.

Another aspect of resource sharing is upload bandwidth and storage space sharing, which can benefit content distribution. Content distribution is the process of transferring content like movies and software ISOs from their sources to their end-users. Conventional content distribution is the Client/Server model in which one server or a cluster of servers provide download service to many clients. In this model, only servers use their capacity to provide the distribution service and so servers are usually the performance bottleneck and the single point of failure. P2P content distribution, on the other hand, splits content into pieces and makes participating peers exchange content pieces with each other. In this way, a peer can download different content pieces simultaneously from multiple peers. Current popular P2P content distribution applications, such as BitTorrent[3], EMule[10], and Xunlei[47], prove that this P2P distribution model can accelerate download processes greatly. Besides excellent performance and scalability, P2P is very reliable as well, since in some degree there is no single-point failure existing in a P2P network. Additionally, because P2P does not require people to have dedicated servers to distribute their content, it is very cheap and easy for common Internet users to share their own content online. The above advantages make P2P be the best choice of content distribution nowadays. According to a statistics report published by CacheLogic[5], the traffic of P2P applications rose dramatically in the past four years and in 2006 up to 70% of ISP traffic is incurred by P2P.

People might ask what kind of content running over P2P networks contributes to the 70% of Internet traffic. Based on my analysis of one-month (April, 2006) traffic of a mid-sized ISP[42] in China, roughly 85% of P2P traffic was used to transfer video and audio files like RMVB, AVI, and MP3; game software ISOs almost accounted for the rest. Now people may concern whether the content delivered by P2P is really legal or not. Most users' experiences with P2P, unfortunately, show that a very large portion of P2P content is pirated. In light of this fact, people may take for granted that P2P has the same meaning as piracy. This is, however, not the truth. In this paper I argue that P2P indeed has a lot of legitimate use although it could help the distribution of illegal content (not the action of piracy) for four reasons. First, people are actually misled by the current situation of P2P piracy and some anti-piracy organizations. Second, P2P is widely used in legal content distribution. Third, P2P even with piracy usually leads to innovative and legal business models. Finally, P2P is in fact killing piracy. P2P is just a content distribution mechanism. It can be used both legally and illegally, so it is unfair to make an equal sign between

P2P and piracy.

The rest of the paper is organized as follows. In Section 2, the fact that a large amount of content on P2P networks is pirated is discussed and the misunderstanding of this fact is analyzed as well. Section 3 illustrates that P2P is used in many legal content distribution applications. The point that now business models originate from P2P with piracy is presented in Section 4. Section 5 proposes that P2P is eliminating piracy. Section 6 concludes.

2. The Misconception

Many people naturally hold the misconception that P2P is piracy. In this section, I analyze today's P2P piracy situation which causes people's misunderstanding towards P2P and further correct the misconception.

2.1. Current Status of P2P Piracy

As a frequent P2P software user, I admit that there is doubtlessly numerous pirated content scattered on current P2P networks. Since P2P content sharing usually involves a large number of anonymous users, it is very difficult for law enforcements to identify pirates and track victims of pirated content. Electronic content pirates exploit this feature and use P2P unlawfully as their primary distribution channel.

Let me do an in-depth analysis of the severity of P2P piracy. First, people would like to know the rough number of pirated content over the Internet. The front page of the Pirate Bay[38], which is the largest public BitTorrent tracker in the world, currently shows that it hosts more than 1.4 million torrent files; the bottom status bar of EMule client software displays that over 600 million files are shared by its users; LimeWire[16], the most widely-used P2P software in the United States, advertises on its homepage that as many as 15 billion contents are served at present; on its webisite, Xunlei[47], which is the most popular P2P software in China, reports that it generates over 500TB Internet traffic every day. In this way, even if only 1% of the content on the Pirate Bay, EMule, LimeWire, and Xunlei is pirated, piracy would be a big problem facing P2P communities. However, according to my recent statistics about several major P2P applications, at least 95% of content served by public P2P file sharing services should not be considered as legit, so P2P piracy is apparently rampant today.

In terms of the number of users (or sometimes called victims) of pirated content, the fact is also startling. The Pirate Bay has more than 10 million registered users worldwide; in China, 3.9 million people are using EMule; Xunlei announced that the number of its users has recently achieved 180 million and the amount of active users per day is 30 million. From these substantial numbers, it is clear to see that an enormous amount of pirated content is affecting a great number of victims.

Obviously, from the above analysis of P2P piracy, anyone can have the impression that P2P is just for piracy.

2.2. Misconception Correction

However, people are in fact misled by these numbers. First, let us consider the example of email. Email, which is even more popular than P2P today, has almost countless spam. Spamhaus's research shows that 90% of incoming email traffic in North America, Europe, and Australasia is spam[35]. Although spam occupies the major part of email, no one complains that email is just for spamming, because email is still a very useful Internet communication tool. If we compare P2P to email and pirated content to spam, it is groundless to think P2P is piracy. Furthermore, in the case of HTTP, there are many file sharing websites like MegaUpload[18] and RapidShare[30] hosting a great number of pirated content[62]. MegaUpload and RapidShare are both ranked top 20 by Alexa[2], which evaluates websites based on the number of their visitors. so the number of pirated content victims is titanic as well, but nobody equals HTTP to piracy either. Therefore, regarding the situation of email and HTTP, I would assert that it is unjustifiable to blame on P2P for piracy.

Besides, some infamous anti-piracy organizations mislead the public into thinking P2P is piracy by exaggerating the financial loss caused by P2P piracy. The MPAA[20] published a report[46] about the file industry loss caused by piracy. The MPAA claimed that its member film studios lost 2.3 billion dollars in 2005 because of Internet piracy (most of such piracy was performed on P2P file sharing services). The amount of lost money really intimidated everyone. Nevertheless, the truth is that the MPAA overrated its loss too much. How did the MPAA get such numbers? The MPAA basically calculated the loss by multiplying the street price of the legally-distributed movies by the number of pirated copies over the Internet. Both [55] and [51] point out this calculation method adopted by the anti-piracy organizations like the MPAA overestimates the loss incurred by P2P piracy since not all users who use online copyrighted material without paying for it would become buyers if copyright infringement is stopped and copyright laws are strictly enforced. Moreover, a customer survey about P2P file sharing[23] shows that 89% of P2P users have bought products after downloading them from a P2P file sharing service. This also proves that the loss alleged by anti-piracy organizations is unconvincing.

Another way used by the anti-piracy organizations to misguide people is to file many lawsuits not only against companies[19] which run P2P services but also against ordinary people. The RIAA[31] even sued a grandmother for

file sharing over KaZaA[13] network [32]. It seems that the anti-piracy organizations like the RIAA can only rely on such ridiculous court cases to bluff people. However, the consequence is that they have already lost their credit and the public tend not to believe their anti-P2P arguments at all.

Last, but not least, P2P is not able to help the action of piracy although it can facilitate the distribution. P2P concerns how to transfer content faster and more reliable, while piracy usually involves reverse engineering and illegal copy. Clearly, P2P and piracy are totally two different stories. It is illogical to make P2P equal to piracy.

In sum, the idea that P2P is piracy is just a misconception believed by many people. People should rethink about their positions against the relation between P2P and piracy.

3. Legal Use of P2P Content Distribution

Although P2P helps the spread of pirated content, it is feasible and has been already extensively used in legal content distribution because of its excellent scalability, high availability, and low cost[61]. This section focuses real cases of P2P application.

3.1. Free Content Distribution

P2P is an ideal way to disseminate free content such as GPLed software like Linux and free videos. Since such content is usually very large in size, if it is delivered in the conventional Client/Server way, the cost is high and the performance is low. Bad user experience would gradually kill the motivation of people to contribute to free online content. Thus, P2P becomes free content's best distribution channel, because of its low cost and high performance. Debian[8], a popular Linux distribution, employs BitTorrent as its primary distribution method. The Linux Mirror Project[37] hosts BitTorrent's torrent files for a bunch of Linux distributions, kernels, and applications. Practices show that Linux distributions can spread rapidly over the Internet with the help of P2P. Free Wikipedia CDs, which aims at assisting schools to improve their curriculum and children learning, are distributed over BitTorrent as well[44]. Free media content can also benefit from P2P. In 2007 China Central Television[6] cooperated with a P2P Video-on-Demand company[22] to make all the programs of its high-rated Chinese New Year Galas since 1982 watchable online for free. This task was successfully accomplished at the cost of only several entry-level PC servers. Additionally, many TV stations broadcast their free live TV programs through P2P live streaming. In China, all leading P2P live streaming service providers such as PPLive[26], PPStream[27], UUSee[40], and QQLive[29] assist major TV stations to implement free online live broadcast. I personally talked with the CTO

of the largest TV station in China. He told me that P2P makes TV channels much more accessible by audiences and hence increases the view rating greatly without paying a high price.

A new class of free content is advertisement-embedded content. An example is electronic magazines. There is a P2P electronic magazine distribution platform[25] in China. Statistics displayed on its website show that more than 639 million copies have been downloaded. Magazine producers benefit from P2P a lot, since they can not only add large-sized multi-media content to their magazines but also spend much less money on printing and delivery. One more advantage is that P2P can reduce the consumption of paper, which is good for our planet. Copyrighted video is distributed in this way too. Xunlei Kankan[48] is a P2P Video-on-Demand service. All its content is legal and free, but users have to watch embedded commercials. Xunlei Kankan attracts a big swarm of users. My friend, who is a network traffic engineer at the largest ISP in Beijing, confirmed that Xunlei Kankan's traffic is ranked Top 1 among all popular P2P applications.

3.2. Non-free Content Distribution

For non-free content distribution, P2P is even more widely used. Proprietary software, which people can get for free but pay for use, are distributed by P2P. Blizzard[4], a renowned game software producer, primarily uses BitTorrent to provide the download service of its 4.9G online game *World of WarCraft* client software for free. Valve[41] developed its multiplayer game distribution platform Steam based on BitTorrent. Steam is adopted by many game software providers. Using P2P to delivery software can eliminate the cost of manufacturing, shipping, and selling DVDs.

As digital right management[9] becomes more and more mature, many content providers start distributing DRMed media content over P2P networks without concerning about copyright infringement. In September 2006, 51TV[1], which is a P2P Video-on-Demand service provider in Shanghai, successfully distributed *The Banquet*, a top-hit Chinese movie, through its P2P network. It used Microsoft's DRM system to prevent illegal copy and sharing. Though it charged consumers $0.50 per view license, the movie was downloaded 200,000 times within seven days. The number of actual viewers was unknown, but from the fact that 51TV made profit from this activity I can infer that there should be enough viewers. Major P2P Video-on-Demand companies in China are offering such kind of DRMed content distribution service.

Current DRM mechanism has many deficiencies like license server dependency and incompatibility with many file formats. DRM can also be bypassed or hacked without much effort. Thus, in order to enhance user experience,

content providers would like to distribute copyrighted content without any DRM protection. They can find other ways to collect money from people. For example, P2P content distributors can have monthly charge plans like cable TV operators's business model. Actually, this kind of business model is proved quite successful. IPTV is a good case to show this. Wasu Online[42], which is the largest IPTV operator in China now, is running its IPTV service on a peer-assisted content distribution system. The monthly charge depends on users' plans. It has about 100 channels and the current number of its users is close to 150,000. In the United States, there is also an IPTV service provider called Kylin TV[15] using P2P to broadcast its channels based on monthly charge. In addition to IPTV, Internet music is another field where such business model is commonly used. iMesh[12], which is as old as Napster[21], began to do copyrighted music distribution in 2005[59]. Now it is serving over 4 million songs licensed from the music industry. People only need to pay $7.95 every month. Kuro[14], a Chinese P2P music sharing software like iMesh, changed to provide legal songs distribution service only, after it was accused of copyright infringement in 2006[57], It charges users $3.00 per month for 200 songs.

3.3. User-generated Content Distribution

User-generated content, which is apparently lawful, is distributed by P2P as well. A popular type of user-generated content is online instant messaging and audio/video chatting data. Since P2P is not only scalable and reliable but also P2P is able to deliver real-time data within deadline, it is very good for instant messaging applications which have to handle with millions of concurrent users requests. A dozen of instant messaging applications utilize P2P to implement text messaging and online audio/video chat. For example, a Chinese instant messaging application, QQ[28], extensively uses P2P to transfer text and audio/video chatting data. QQ can periodically find the near-optimal application-layer routes from a user to his/her online buddies so that it can offer the best user experience. According to its statistics, QQ has over 300 million registered users and in 2007 the number of users who are simultaneously online achieved 30 million. Such a massive user population is handled very well by QQ's P2P engine. From my personal experience, the service quality is much better than Windows Live Messenger[45] which uses the conventional Client/Server model. Skype[34] is another P2P instant messaging software that is more familiar by the world. Research[56][52] shows that Skype's VoIP(Voice-over-Internet-Protocol) is based on KaZaA[13] and it has peers to relay voice traffic. The popularity of Skype shows that P2P can transfer real-time generated content very well.

Besides ephemeral content generated by users, users can

produce their own persistent content like digital videos and share them over P2P networks. Many campus videos produced by college students in China are usually published through BitTorrent. Youtube and its counterpart Youku[49] in China are a big thread to P2P video sharing, but their Client/Server model lacks good support to distribute today's more and more popular high-quality videos, so P2P is still widely used. In addition, podcast is a new P2P application area. Dave Slusher does his well-known podcast[64] using BitTorrent.

3.4. Special-purpose Content Distribution

Special-purpose content, such as business data and scientific data, is distributed over P2P networks now. Large-sized business data, such videos of commercials and operation logs, are hard to delivery because of their large size. If a company tries to deliver its commercials to many TV Stations spreading worldwide in a traditional Client/Server way like FTP, the process of publishing new commercials would be very slow and the company might even prefer to send DVD copies by express mail. With the help of P2P content distribution network, however, the company can make its advertisement arrive at TV stations on time. I personally joined such a project that helped a famous fast food chain to deliver its commercials to more than 30 TV stations in China over a P2P content distribution network. The fast food giant was very content with the performance.

Nowadays, very large-scale research cooperations are more and more common, researchers at geologically dispersed locations usually want to share experiment data. Scientific research data are often very large. For example, LHC experiment at CERN[36] can generate petabytes of data. The data, according to the collaboration agreement, have to be available to participating research institutions and universities all over the world. Obviously, this one-to-many data distribution is a challenging task. [50] researched this issue and proposed that P2P performs better than other techniques in large-scale grids. [54] even discussed grid programming details from the perspective of P2P networks. [58] further investigated the implementation issues of P2P scientific applications. LionShare[17], created by Pennsylvania State University, is a great step towards the realization of P2P scientific data distribution. As far as I know no mature scientific data distribution has been done yet, but I am still optimistic to see this application will happen in near future.

In sum, P2P delivers at least four major types of legal content at present. P2P apparently has a lot of legal uses on today's Internet, therefore it is quite reasonable to infer that P2P should not be always connected to pirated content distribution.

4. P2P Business Model Innovation

Not only does P2P helps distribution of legal content, but also P2P gives birth to new legit business models of Internet.

First, P2P stimulating users to buy quality products even if they get pirated online. The anonymous P2P customer survey[23] measured the percentage of people buying products after discovering them in P2P networks. To everyone's surprise, the result was totally contrasted with what the anti-piracy organizations claimed. 49% of downloaders did purchase products occasionally. 30% even bought such products monthly. The survey further concluded an interesting point that people downloading files from P2P networks are not for money saving but for product quality evaluation. In other words, if a product is really good, P2P even with piracy can increase the sale; while if a product is not good, nobody will buy it in reality, which is OK because bad products deserve this. [55] did a qualitative research on this and proposed a method of maximizing the profit in the P2P environment. Thus, P2P gives businesses a new way to advertise their products.

Moreover, many effective and brand-new business models are directly originated from by P2P. An MBA paper[53] investigates the relationship of P2P with piracy and new legal business models. By analyzing the cases of Napster and BitTorrent, the paper obtains three very interesting observations: the first point is that P2P users are pioneers of using cutting-edge technologies; the second is that P2P user communities are the source of new market; the last is that P2P piracy can create new market. Similar insights are also discovered in other sources like [60]. Here I would like to present one more case of P2P and new business models. The example is IPTV. The traditional way to do IPTV is to build new dedicated transmission devices or upgrade existing ones in order to achieve required QoS. This is costly. However, P2P IPTV does not need any special and complex equipments and configuration except set-tops, since P2P is cost effective in guaranteeing QoS of real-time video content[63]. In this way, P2P makes the business model of IPTV evolve into a new generation. P2P IPTV now is mature enough to overhaul the IPTV industry. Successful examples like Wasu Online[42] and Kylin TV[15] show the business model of IPTV must be based on P2P. One of the independent directors of China Unicom[7](the largest telecommunication operator in northern China) comments that P2P IPTV solves the scalability problem of Client/Server IPTV and further predicts that P2P IPTV will replace traditional IPTV very soon.

Therefore, P2P even with piracy is an incubator of many innovative business models.

5. P2P, the Piracy Killer

Readers now commonly may think although P2P is not only for piracy it can lend great help to piracy. This is very natural but superficial. If readers do more in-depth research, they will find out that P2P is actually the killer of piracy.

The first reason why P2P destroys piracy is that P2P makes some pirates earn much less money. Pirated content users nowadays often download the content from P2P networks for free. To "enjoy" pirated content, users just sit at home, install some P2P application, search what they like, click to start download, and wait for the completion of download. They do not have to explicitly buy DVDs and CDs from pirated content distributors. This is a big convenience for users, but a horrible nightmare for pirates. Piracy victims do not spend money on getting pirated content any more; the distributors of such content would lose their only source of money, so they could not make profit from piracy. As a result, the distributors would have to shut down their DVD and CD burning factories and they would not pay any money to real pirates or hackers. Hackers would be less motivated to do tough reverse engineering against proprietary software and illegal copying. In this way, P2P can elinimate piracy from its source. The above reasoning is true in reality. Personally, I know someone who hacked and built pirated software DVDs and CDs a couple years ago, but now he does not do this dirty business any longer. From him, I learned that when P2P became popular he could not sell enough pirated copies to his distributors to afford his living and so he quitted this business immediately. He also told me that the number of hardcore hackers is much less than several years ago. The same thing happened in the United Kingdoms[24]. A so-called "physical" pirate stopped his piracy activity since P2P took away all his customers. P2P makes people unwilling to pay even a penny for illegal content.

Since P2P has already ruled out the money source of "physical" piracy, pirates have to find other profitable ways to continue piracy, however they are still not quite successful because of P2P. The easiest way to make profit from piracy in the P2P environment is to implant adware or spyware into pirated software and certain types of video files. Pirates can get money based on how many copies are actually used by victims. Since P2P can help pirates to delivery as many copies as possible, thet are highly motivated again and are willing to crack and distribute illegal content over P2P networks. Nonetheless, since many people could be victims of such pirated content, they can identify pirates' dirty tricks immediately, stop using pirated content as soon as possible, and even help law enforcements to track pirates. Furthermore, pirated content embedded with malware can easily scare its customers. After all, people would buy legal content rather than download illegally. For example, a pop-

ular function-enhanced pirated version of Microsoft Windows XP in China was discarded by its users[67], because a bunch of malware were discovered by P2P users.

In short, P2P starts squeezing the living space of piracy. In near future it is very likely that piracy will eventually die at the hand of P2P.

6. Conclusion

P2P, like the nuclear technology, is a double-edged powerful weapon. It could be used by pirates to illegally and massively distribute pirated content. People are easily misled into establishing the misconception that P2P has little to zero legitimate use. They basically neglect the other sharp edge of P2P. This paper discusses the positive aspects of P2P in detail. First, the misconception is analyzed and corrected. Then, I present extensive examples of legal use of P2P to illustrate that P2P is commonly utilized to distribute legal content. Further, the paper discusses that creative and successful business models stem from P2P even with piracy. Last, but not least, the in-depth investigation of the relationship between P2P and piracy shows that P2P is suppressing piracy. With so many supporting evidences listed above, it is sound to conclude that P2P does not equal to piracy and it does have lots of legal use.

P2P is considered as the future of the Internet. In academia, P2P is one of the hottest network research fields. Tons of P2P papers are published every year. Top conferences such as SIGCOMM, NSDI, and INFOCOM all have dedicated sessions for P2P research. In industry, leading P2P software producers, ISPs, network equipment manufacturers, and research universities, such as AT&T, BitTorrent, Cisco Systems, and Yale University, initiate the P4P[66] working group in order to optimize ISP network resource utilization and to improve P2P end-user experience. Foreseeing the bright future of P2P, governments around the world begin to build their own blueprints of P2P as the infrastructure of the next generation Internet. In GENI(Global Environment for Network Innovations)[11] initiative funded by NSF in the United States, P2P is a major focus, since the idea of GENI's infrastructure basically originated from P2P. P2P also plays a significant role in CNGI(China Next Generation Internet) sponsored by National Development and Reform Commission of China. For P2P Video-on-Demand alone, CNGI invested 3 million dollars. The total amount of funding on P2P research has exceeded IPv6 which is another important topic of CNGI. In the early 2008, the European Union announced its 14 million euros investment to P2P IPTV research[65]. The project tries to build a P2P IPTV system that can be set as the industry standard. A social BitTorrent client Tribler[39], BBC, and other research institutions are funded to carry out the development and research. In short, considering the fact that academia, industry, and government are all advocating and propelling P2P, how come people can deny that P2P $\neq$ piracy?

References

[1] 51TV. http://www.51tv.net.
[2] Alexa. http://www.alexa.com.
[3] BitTorrent. http://www.bittorrent.org.
[4] Blizzard Entertainment. http://www.blizzard.com.
[5] CacheLogic. http://www.cachelogic.com.
[6] China Central Television. http://www.cctv.com.
[7] China Unicom. http://www.cnc.cn.
[8] Debian. http://www.debian.org.
[9] Digital Right Management. http://en.wikipedia.org/wiki/Digital_rights_management.
[10] EMule. http://www.emule-project.net.
[11] Global Environment for Network Innovations. http://www.geni.net.
[12] iMesh. http://www.imesh.com.
[13] KaZaA. http://www.kazaa.com.
[14] Kuro. http://www.kuro.com.cn.
[15] Kylin TV. http://kylintv.com/index.asp.
[16] LimeWire. http://www.limewire.com.
[17] LionShare. http://lionshare.its.psu.edu.
[18] MegaUpload. http://www.megaupload.com.
[19] MGM Studios vs. Grokster. http://en.wikipedia.org/wiki/MGM_Studios,_Inc._v._Grokster,_Ltd.
[20] MPAA. http://www.mpaa.org.
[21] Napster. http://en.wikipedia.org/wiki/Napster.
[22] Nibaa. http://www.nibaa.cn.
[23] P2P Customer/Consumer Survey. http://www.p2punite.org/?q=node/206.
[24] P2P File-Sharing Ruins Physical Piracy Business. http://torrentfreak.com/p2p-file-sharing-ruins-physical-piracy-business.
[25] POCO. http://read.poco.cn.
[26] PPLive. http://www.pplive.com.
[27] PPStream. http://www.ppstream.com.
[28] QQ. http://im.qq.com.
[29] QQLive. http://tv.qq.com.
[30] RapidShare. http://rapidshare.com.
[31] RIAA. http://www.riaa.org.
[32] RIAA vs. Grandma. http://www.boingboing.net/2003/09/25/riaa-sues-grandmothe.html.
[33] SETI@HOME. http://setiathome.berkeley.edu.
[34] Skype. http://www.skype.com.
[35] Spamhaus. http://www.spamhaus.org.
[36] The Large Hadron Collider. http://lhc.web.cern.ch/lhc.
[37] The Linux Mirror Project. http://www.tlm-project.org.
[38] The Pirate Bay. http://thepiratebay.org.
[39] Tribler. http://www.tribler.org.
[40] UUSee. http://www.uusee.com.
[41] Valve Software. http://www.valvesoftware.com.

[42] Wasu Online. `http://www.hzcnc.com`.

[43] Wikipedia. `http://www.wikipedia.org`.

[44] Wikipedia CD Distributed over BitTorrent. `http://torrentfreak.com/wikipedia-cd-distributed-over-bittorrent`.

[45] Windows Live Messenger. `http://im.live.com`.

[46] Worldwide Study of Losses to the Film Industry and International Economies due to Piracy. `http://www.slyck.com/misc/mpaa_loss.doc`.

[47] Xunlei. `http://www.xunlei.com`.

[48] Xunlei Kankan. `http://kankan.xunlei.com`.

[49] Youku. `http://www.youku.com`.

[50] S. Al-Kiswany, M. Ripeanu, A. Iamnitchi, and S. Vazhkudai. Are P2P Data-Dissemination Techniques Viable in Today's Data-Intensive Scientific Collaborations? In *Proceedings of the 13th International Euro-Par Conference*, 2007.

[51] N. Anderson. Studies: Music Industry Overstating Threat of P2P Piracy. `http://arstechnica.com/news.ars/post/20070531-studies-music-industry-overstating-threat-of-p2p-piracy.html`.

[52] S. Baset and H. Schulzrinne. An Analysis of the Skype Peer-to-Peer Internet Telephony Protocol. `http://arxiv.org/abs/cs.NI/0412017`.

[53] D. Choi. Online Piracy and the Emergence of New Business Models. `http://www.sbaer.uca.edu/Research/usasbe/2006/pdffiles/papers/cases/016.pdf`.

[54] D. Gannon, R. Bramley, G. Fox, S. Smallen, A. Rossi, and R. Ananthakrishnan. Programming the Grid: Distributed Software Components, P2P, and Grid Web Service for Scientific Applications. *Cluster Computing*, 5, 3:325–336, 2002.

[55] A. Gayer and O. Shy. Internet and peer-to-peer distribution in markets for digital products. *Economic Letters*, 81, 2:197–203, 2003.

[56] S. Guha, N. Daswani, and R. Jain. An Experimental Study of the Skype Peer-to-Peer VoIP System. In *Proceedings of the 5th International Workshop on Peer-to-Peer Systems*, 2006.

[57] J. Ho. Kuro Case Sets P2P Precedent in China. `http://www.allbusiness.com/retail-trade/miscellaneous-retail-retail-stores-not/4392541-1.html`.

[58] A. Iamnitchi, M. Ripeanu, and I. Foster. Locating Data in (Small-World?) Peer-to-Peer Scientific Collaborations. In *Proceedings of the 1st International Workshop on Peer-to-Peer Systems*, 2002.

[59] N. McKay. Peer-to-Peer Goes Legit. `http://www.wired.com/entertainment/music/news/2005/11/69457`.

[60] T. Mennecke. P2P Pirates are iTunes' Best Friend. `http://www.slyck.com/story870_P2P_Pirates_are_iTunes_Best_Friend`.

[61] P. Rodriguez, S.-M. Tan, and C. Gkantsidis. On the feasibility of Commercial, Legal P2P Content Distribution. In *Proceedings of the IEEE 10th International Workshop on Web Content Caching and Distribution*, 2005.

[62] J. Roettgers. Piracy Beyond P2P: One-Click Hosters. `http://newteevee.com/2007/06/17/one-click-hosters/`.

[63] A. Sentinelli, G. Marfia, M. Gerla, and L. Kleinrock. Will IPTV Ride the Peer-to-Peer Stream. *IEEE Communicatoins Magazine*, 45, 6, 2007.

[64] D. Slusher. Evil Genius Chronicles. `http://www.evilgeniuschronicles.org/wordpress`.

[65] M. Ward. Europe Funds Internet TV Standard. `http://news.bbc.co.uk/2/hi/technology/7259339.stm`.

[66] H. Xie, R. Yang, A. Krishnamurthy, Y. Liu, and A. Silberschatz. P4P: Provider Portal for Applications. In *Proceedings of ACM SIGCOMM 2008*, 2008.

[67] W. Xing. Rotten Tomatos. `http://www.chinadaily.com.cn/bw/2008-09/22/content_7045510.htm`.