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PEER TO PEER NETWORKS IN OECD COUNTRIES

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Chapter 5 OECD Information Technology Outlook 2004
Section on Peer-to-Peer Networks

Peer-to-peer digital delivery

Though still relatively new, the P2P file-sharing marketplace is evolving rapidly. It may be one of the most important factors in changing how digital delivery is done. Together with new compression technologies and formats like MP3 and more widely shared and faster broadband access, this technology has also greatly influenced how traditional entertainment industries operate. Moreover, specific challenges for copyright protection are raised.

This section of the Chapter 5 of the Information Technology Outlook 2004 focuses on measuring the use of P2P networks for the non-commercial downloading of music, video and software files in OECD countries. Free downloading of music, films, or other files does not generate revenues for copyright holders (artists, music, publishers) and may negatively impact the development of new legitimate services delivering music, movies, etc. to customers. Some argue that downloading supplements regular purchases of music or serves as way to sample new music (Pew, 2003). However, the recording industry has also warned that free downloading poses a severe threat to the music industry in terms of diminishing sales. [1] There are currently a significant number of lawsuits in OECD countries to prevent infringement of copyright when P2P networks are used to share commercial music and films. This section analyses the current impact of this new technology for digital delivery as a way to shed light on the potential for the commercial use of P2P technologies and policy issues.

Peer-to-peer file sharing

Peer-to-peer is essentially a communication structure in which individuals interact directly, without going through a centralised system or hierarchy. Users can share information, contribute to shared projects or transfer files (OECD, 2002; Minar and Hedlund, 2001).
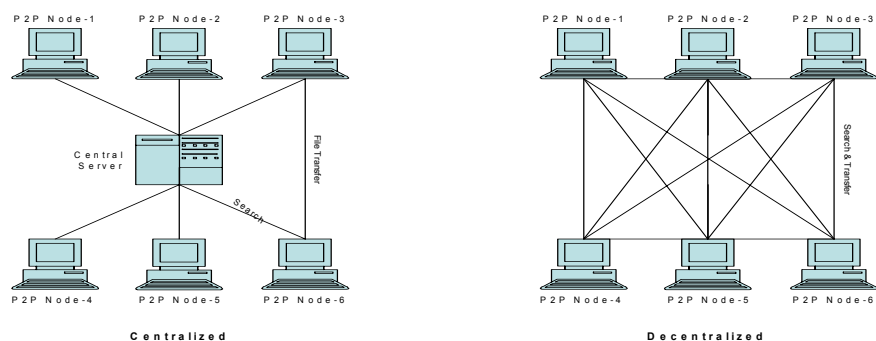
In the past, systems for sharing files and information between computers were limited. The picture changed radically when in 2001, Napster had a daily average of 1.57 million simultaneous users and 60 million daily users worldwide. Napster was the first file-sharing service that allowed the non-commercial trade of music. In mid-2001 Napster was closed down owing to increasing lawsuits by the music industry.

Since Napster has been restricted, imitators such as Audiogalaxy, Morpheus, Gnutella and KaZaA have become more widely used. P2P thus emerged as the dominant use of bandwidth by residential Internet subscribers; it can consume 30% of network bandwidth of some broadband providers (Blue Coat, 2004). Most current P2P applications are not 100% P2P, but hybrid versions that make some use of central servers, which can ensure accountability and/or quality. Unlike Napster, for example, Gnutella does not have a central directory server; users connect directly to other nodes within the immediate vicinity and request a file (see Box 5.1 for an explanation of centralised vs. decentralised P2P systems).

Although file sharing consumes large amounts of bandwidth, broadband access does not seem to be a precondition for file sharing. P2P use actually outpaces broadband adoption. New subscribers begin sharing files earlier and existing subscribers share files more often. The evolution from Napster to Gnutella to KaZaA and BitTorrent, and now eDonkey and WinMX (in Europe), has radically increased the amount of data transferred across broadband networks (Sandvine, 2003). Over KaZaA, for instance, almost 5 000 terabytes of information, including over 600 million files, are shared by an average of 3 million users at any given time (Lyman and Varian, 2003).

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Box 5.1. Forms of P2P file sharing

The dominant forms of P2P file-sharing systems are:

P2P Node-1   P2P Node-2   P2P Node-3   P2P Node-1   P2P Node-2   P2P Node-3

Central Server   File Transfer   Search   Search & Transfer

P2P Node-4   P2P Node-5   P2P Node-6   P2P Node-4   P2P Node-5   P2P Node-6

Centralized   Decentralized

Centralised system: First generation P2P (*e.g.* Napster) utilises a server-client network structure. This one-to-many relationship enables a single host to communicate and share files with multiple nodes. The central server acts as a sort of "traffic cop". It maintains directories of shared files stored on each node. Each time a client logs on or off the network, the directory is updated. The centralised P2P framework provides the best performance in terms of locating files. Every individual in the network must register; this ensures that all searches are comprehensive and are executed quickly and efficiently.

Decentralised system: The many-to-many relationship used by Gnutella protocol clients like BearShare enables highly automated resource sharing among multiple nodes. A decentralised framework does not rely on a central server and is therefore more robust than a centralised system.

Third generation P2P (*e.g.* FastTrack, KaZaA, Grokster, Groove, and current Gnutella clients) employs a hybrid of the central-server and fully decentralised frameworks (controlled decentralised framework).

Source: Sandvine, 2003; OECD, 2002; Minar and Hedlund, 2001.

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More recent systems like BitTorrent and eDonkey make it easier to distribute large files to a large numbers of people, because users who want a file are sharing with each another, simultaneously uploading and downloading pieces of the same file or different files simultaneously, rather than downloading from a central source. In essence, the BitTorrent system makes it easy to distribute very large files to many people while placing minimal bandwidth requirements on the original uploader of the file. Other improvements are making new P2P technologies more efficient at finding what is available in all distributed networks and helping ISPs by significantly reducing Internet traffic caused by P2P search queries (Technewsworld, 2004).

P2P use in OECD countries

BigChampagne provides data on country-specific use of P2P networks, their evolution and determinants of use.[2] It does so by indexing and searching shared folders on P2P networks and tracks some 50 million search queries a day to determine the activity and origin of P2P users. The data show the activity and origin of P2P users that are logged on to the given P2P network, providing a reliable indicator for the number of individuals using file-sharing networks to upload or download files. BigChampagne began monitoring Napster in 2000 and now covers the most popular networks, including FastTrack (KaZaA, Kaza Lite, iMesh, Grokster, etc.), eDonkey, Direct Connect. All Gnutella-based clients like ScourExchange, AudioGalaxy, Morpheus are also covered. However, it does not track less popular P2P sites, such as Soribada in Korea or FileRogue in Japan, or smaller ones in other OECD countries.[3]

Today more than 60 million US consumers appear to see file sharing as a convenient, efficient and enjoyable way to obtain digital content (PC Magazine, 2003). As Figure 5.5 shows, global P2P use of the popular fast-track networks (i.e. KazAa) increased by roughly 1.5 million simultaneous users (users who are jointly connected at any given moment) on FastTrack file sharing networks from September 2002 to September 2003. A peak of more than 5.5 million simultaneous users was reached in October 2003 but the number has since dropped back to around 4.5 million.

On the one hand, this decline is attributed to an increase in lawsuits against users of P2P networks and the rise of successful commercial music downloading services (*e.g.* Apple's iTunes, an online music store). Recent PEW surveys suggest that, owing to increasing lawsuits by the record industry[4] and the rapid adoption of commercial on-line music sales, the number of people in the United States swapping music files on line has dropped by half, while the number of people downloading files on any given day has dropped by 75% since mid-2003 (Pew and comScore, 2004; *New York Times*, 2004). In a survey of 1 358 Internet users conducted from 1 March to 20 May 2003, 29% of Internet users admitted to downloading free music. The percentage dropped to 14% in a survey conducted 18 November to 14 December 2003. In November 2003, for example, 3.2 million Americans visited Napster.com, which was re-launched as a paid on-line music service in late October, while Apple's iTunes, an on-line music store, drew 2.7 million visitors in November 2003.[5]

On the other hand, it is argued that the fall only represents a "return to normal", as sharing levels are again back to the four months preceding October 2003. The Pew figures may overstate the drop in file sharing because survey respondents are now more reluctant to admit to engaging in downloading activity. Interestingly, a look at the figures for all P2P networks (fast-track plus other networks) shows an increase from August 2002 to April 2004 to close to 10 million simultaneous users. Part of this steady rise of other networks can be explained by the fact that consumers have – in the light of increasing lawsuits against P2P users - left fast-track networks which are monitored more frequently. The rather flat evolution of the fast-track networks since November 2003 and the parallel rise of simultaneous use of other networks may hint at a migration of P2P users to networks that attract less attention from the music industry and connected lawsuits.

Figure 5.5. Global FastTrack and other P2P network growth, simultaneous audience, August 2002-April 2004
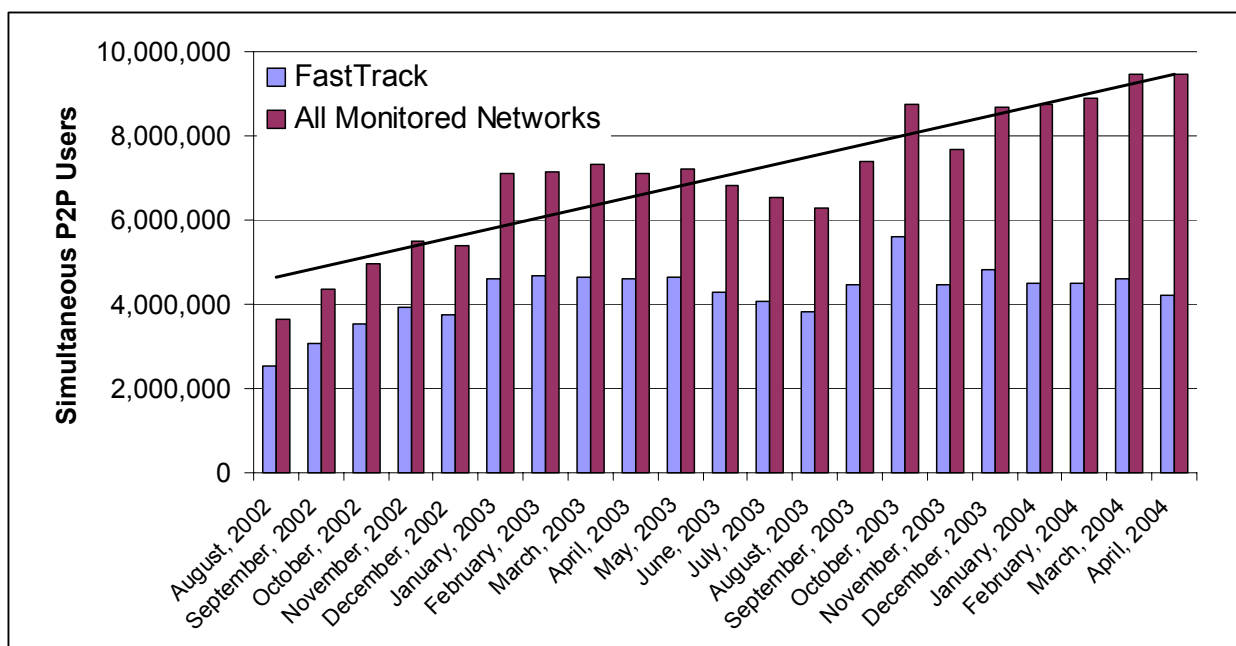
* black line is the trend line for "All Monitored Networks".

Source: OECD, based on BigChampagne data.

In terms of the distribution of P2P users, 55.4% originate from the United States. Germany accounts for 10.2%, Canada for 8%, France for 7.8%, United Kingdom for 5.4%, Italy for 1.7%, Spain for 1.1% and the Netherlands for 1% (see Table 5.8). No other OECD country accounts for more than 1%, although it must be recalled that BigChampagne does not cover Japanese and Korean sites. When weighted by population, Canadians seem to be the most intensive users (1.2% of total population). In no other country does the number of users, as a share of total population, exceed 1%. On average 0.24% of the OECD population is logged on simultaneously to a P2P network. If the data were weighted by number of Internet users rather than by the general population, average use of P2P would be much higher.

The studies conducted on US P2P users show that music downloading has been one of the fastest-growing Internet activities. A survey by Pew (2003) conducted between March and May of 2003 found that 29% of Internet users have downloaded music files to their computer and that about 4% do so on an average day. The proportion was the same as in the previous survey of 2001 (Pew, 2001) but the absolute number was larger owing to overall growth of the on-line population. More than three-quarters (79%) of adult US Internet users who download music indicated that they do not pay for the files the download, and some two-thirds do not care whether the files are copyrighted or not. A study for France has shown that 30% of Internet users (from age 12) have downloaded music or other files over P2P networks (CREDOC, 2003) and that 15% of French Internet users who had not yet used P2P networks planned to do so in the next 12 months. Another study from May 2004 (CNC, 2004) found for France that more than 31 millions films are downloaded via non-commercial means per month. It is judged that around 19 % of French Internet users have already downloaded and watched movies at home. Only 4 % of Internet users have actually paid for viewing films online.

Table 5.8. Distribution of P2P users in OECD countries, 2003
Percentage of all users and percentage of the total population

OECD country		Percentage of all users	OECD Country		P2P users as a percentage of total population, Sept.-Oct. 2003
1.	United States	55.4	1.	Canada	1.2
2.	Germany	10.2	2.	United States	0.9
3.	Canada	8.0	3.	France	0.6
4.	France	7.8	4.	Germany	0.6
5.	United Kingdom	5.4	5.	Luxembourg	0.4
6.	Italy	1.7	6.	United Kingdom	0.4
7.	Spain	1.1	7.	Sweden	0.4
8.	Netherlands	1	8.	Belgium	0.4
9.	Australia	0.91	9.	Switzerland	0.4
10.	Belgium	0.8	10.	Austria	0.3
11.	Sweden	0.7	11.	Netherlands	0.3
12.	Japan	0.7	12.	Norway	0.3
13.	Switzerland	0.6	13.	Australia	0.2
14.	Austria	0.5	14.	Finland	0.2
15.	Mexico	0.3	15.	Denmark	0.2
16.	Norway	0.3	16.	New Zealand	0.2
17.	Korea	0.2	17.	Italy	0.1
18.	Portugal	0.2	18.	Spain	0.1
19.	Poland	0.2	19.	Iceland	0.1
20.	Finland	0.2	20.	Portugal	0.1
21.	Denmark	0.2	21.	Ireland	0.1
22.	New Zealand	0.1	22.	Japan	0.1
23.	Ireland	0.1	23.	Hungary	0.02
24.	Hungary	0.1	24.	Poland	0.02
25.	Greece	0.1	25.	Greece	0.02
26.	Luxembourg	0.04	26.	Korea	0.02
27.	Czech Republic	0.04	27.	Czech Republic	0.01
28.	Turkey	0.03	28.	Mexico	0.01
29.	Slovak Republic	0.01	29.	Slovak Republic	0.01
30.	Iceland	0.01	30.	Turkey	0.00
OECD countries		96.9	OECD average		0.24

Source: OECD based on BigChampagne data.

For other OECD countries, music downloading does not necessarily, but is likely to, take place over P2P networks. In Finland, for example, the number of Internet users aged 10-30 who have downloaded an MP3 file to their PC[6] rose from 33% in 1999 to 46% in 2002 (Statistics Finland, 2003). In Canada, 24.3% of all households (up from 7.8% in 1999) obtain and save music over the Internet (Statistics Canada, 2003). In Japan, in 2002, 17.9% of broadband users (6.2% of narrowband users) downloaded music and 19% of broadband users (3.8% of narrowband users) downloaded videos (MPHPT, 2003). This demonstrates the importance of broadband for downloading large files.

The Pew studies for the United States also show considerable overlap between downloading and sharing populations (Pew, 2003), as 42% of those who download files say they also share files with others. Out of all Internet users, 17% download music but do not share files on line, 9% share files on line but do not download music, 12% both download music and share files, and 62% do not download music or share files at all.

The evolution of country-specific shares in P2P use from 2002 to 2003 (not weighted by population) indicates that French, German, Japanese and Italian shares have grown fastest, while those of the United States, Belgium and the United Kingdom are decreasing (significantly in the United States which started with a very large share) (Annex Figure C.5.1). The strong growth rates for European countries, for instance, can be explained by the fact that P2P has become popular later than in, for instance, the US. Other OECD calculations based on BigChampagne data show that countries with an initially very low share of P2P users (like Turkey, Czech Republic, Luxembourg, Greece, Mexico, Japan, New Zealand, Poland, Hungary and Portugal) have seen strong growth in their market share.
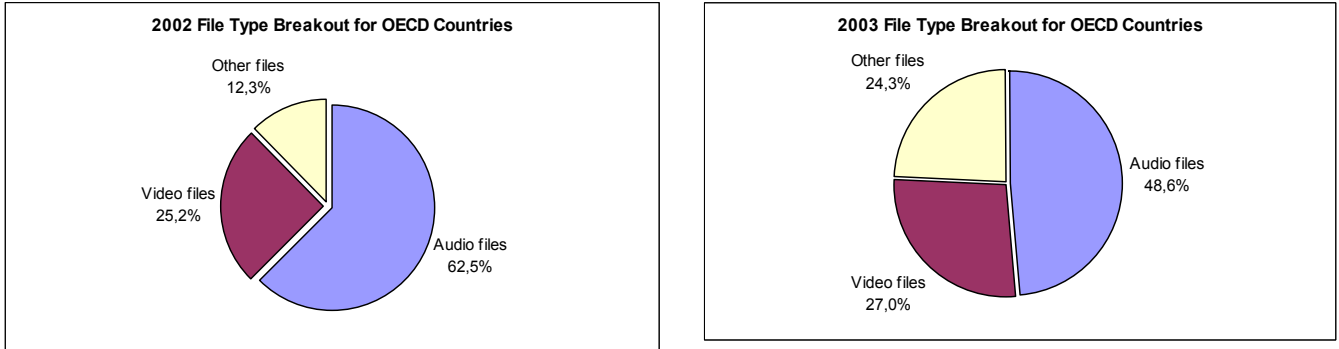
The ongoing increase of European P2P usage and the decrease of the share of the United States are mirrored again in the evolution of country-specific shares in P2P use from 2003 to 2004 (Figure 5.6).

Figure 5.6. Change in share of global P2P user base, January 2003 to January 2004

Country	Change In Share of Global P2P User Base Jan. '03 to Jan. '04
Canada	4.5%
France	4.4%
United Kingdom	3.7%
Germany	3.6%
Spain	1.2%
Japan	1.1%
Austria	0.8%
Netherlands	0.7%
Belgium	0.6%
United States	-23.53%

Some interesting points can be made concerning the type of files shared. Napster only allowed users to share music files in the popular MP3 format. Today, however, video and other files (*i.e.* software) make up more than 35% of total files offered over file-sharing networks. Indeed, the share of video and software files traded increased significantly between 2002 and 2003, while the share of audio files decreased from 62.5% to 48.6% (Figure 5.7). According to BigChampagne, the increased downloading of video files is due to higher available bandwidth (depending on the technology a 2.5 hour movie can now be downloaded in minutes) and new DVD and CD burning technologies. In the United States, one in five young file sharers has downloaded a movie. By 2008, revenues from DVDs and tapes are expected to drop by 8%, while various forms of video on-demand will gross USD 4.2 billion (Forrester Research, 2003). . Consequently non-commercial downloading is a also threat to the sale of hard media (CDs, videos, etc.).

Figure 5.7. Breakdown of file sharing for OECD countries, 2002 and 2003

2002 File Type Breakout for OECD Countries

Other files
12,3%

Video files
25,2%

Audio files
62,5%

2003 File Type Breakout for OECD Countries

Other files
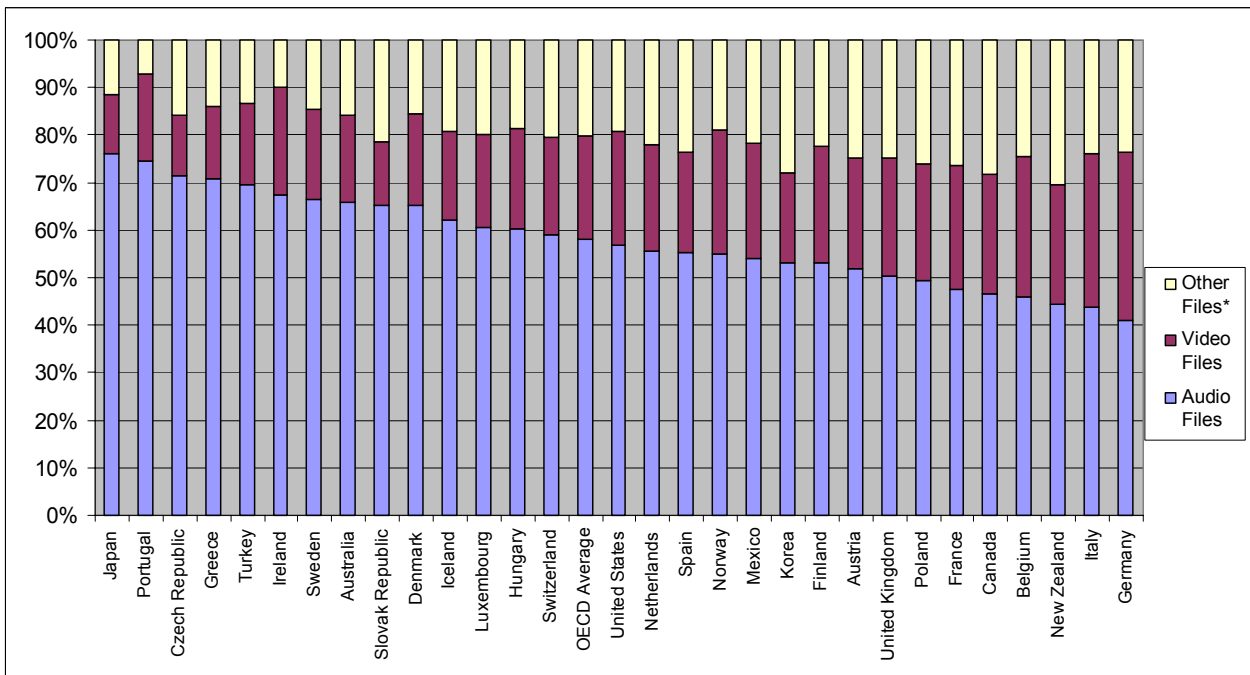24,3%

Audio files
48,6%

Video files
27,0%

Note: Other files include software, documents, images and other files not included in the video and audio categories. The numbers indicate the files available for upload on P2P networks. Owing to the close correlation of uploaded and downloaded files, the figures are representative for downloaded files.

Source: OECD based on BigChampagne data.

Figure 5.8 shows the breakdown of file use for individual OECD countries on KaZaA, a popular P2P network.

Figure 5.8. File breakdown for OECD countries based on peak simultaneous KaZaA users, September-October 2003

Note: Other files include software, documents, images and other files not included in the video and audio categories. The data are not representative of other P2P networks.

Source: OECD based on BigChampagne data.

To access video and software files, Germany, Italy and New Zealand use P2P networks the most and Japan, Portugal and the Czech Republic the least. Other studies indicate that video content is more popular in Europe than in other OECD countries. This is partly due to the fact that the P2P technology most used in Europe (eDonkey) is particularly useful for sharing large files (600 MB or more), whereas most US users

rely on FastTrack, which is a better resource for sharing smaller music and software files (3-7 MB) (Sandvine, 2003).

Lyman and Varian (2003) have found that the total size of video files being shared is greater than that of audio files (Table 5.9). The average size of an ".avi" file (a common video format) is 162 MB, while the average size of an ".mp3" (the most common audio format) is about 4 MB). In terms of the total number of individual files (as opposed to their cumulative size), audio is the most shared format by far. The files most commonly shared by P2P users are MP3 files, music files encoded using MP3 technology and .kpl files (KaZaA play list files). Lyman and Varian (2003) find that MP3 files use up to 30% of file users' hard disks. Image files (.jpg, .bmp) are also popular.

Table 5.9. Size of traded files, 2003

| Type	Sum of size (GB)	Number of files	Percentage of total size
Video	8 661.6	126 217	58.7
Audio	4 929.4	1 253 308	33.4
Software	648.3	85 072	4.4

Source: Lyman, P. and H.R. Varian (2003), "How much Information 2003", www.sims.berkeley.edu/research/projects/how-much-info-2003/.

The ever-increasing amount and diversity of copyright-protected content circulating over P2P networks clearly present a challenge to governments and to firms. First, businesses are confronted with degraded network availability, reduced bandwidth, potentially lost worker productivity and the threat posed by the presence of copyrighted material on their networks (Blue Coat, 2004). Second, copyright owners fear the instantaneous non-commercial redistribution of their works. Governments and courts face the challenge of determining what part of such activity is illegal and how intellectual property right frameworks have to be adjusted and enforced to reduce illegal file sharing.

Determinants of P2P use

Plotting the availability of broadband against P2P use (Figure 5.9) shows a positive relationship between P2P use and broadband availability. Studies for the United States indicate that availability of broadband increases downloading of music, films and other copyrighted works. According to Pew (2003), 41% of US Internet users with a broadband connection at home have downloaded music versus a quarter of dial-up users.

Figure 5.9. Relationship between broadband access and P2P use in selected OECD countries
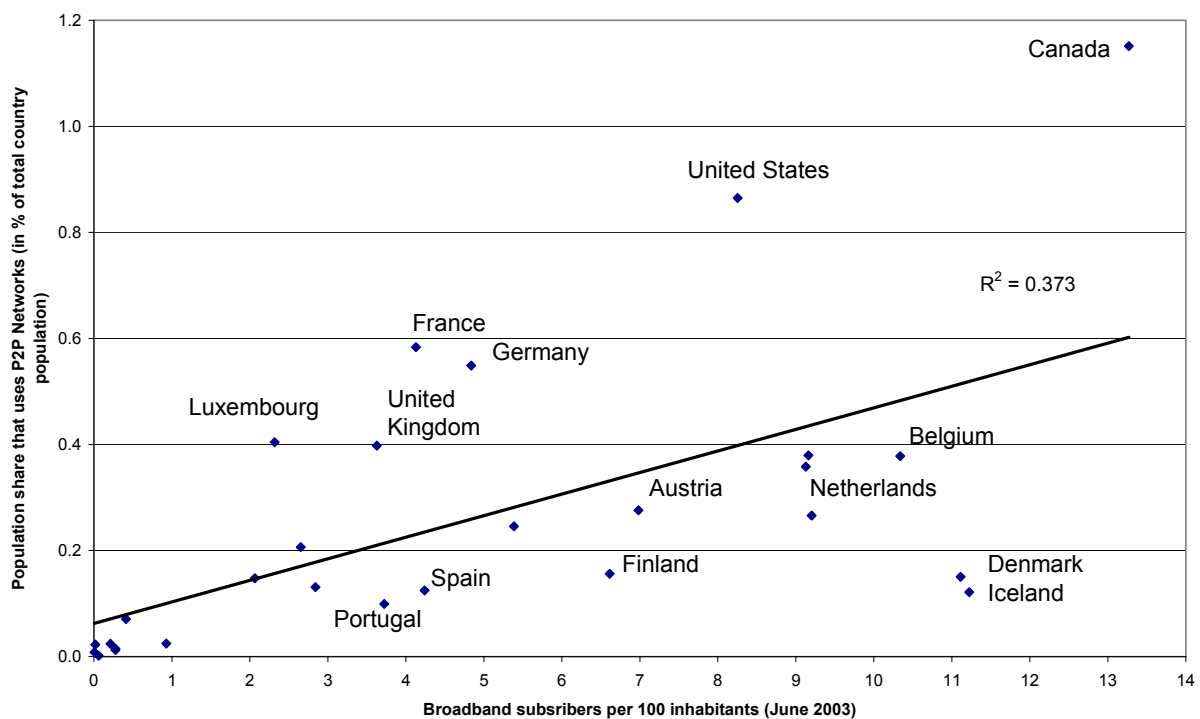
Source: OECD, based on BigChampagne data and OECD ICT database.

However, the availability of broadband alone does not explain P2P use (R-square: 0.37). Broadband certainly has a positive effect on the spread and intensity of P2P use (especially on the size of exchanged files). However, low bandwidth did not deter P2P users before the advent of broadband. For some Internet users (especially students), the desire to use P2P networks more efficiently, may actually have influenced their choice of upgrading their Internet connection to broadband. In this case, it is actually the availability of content which drives broadband up-take and not the other way around. Additional important explanatory variables include factors such as age, educational attainment, income and whether or not the Internet user is a student.

Younger US Internet users are the most active P2P downloaders (Pew 2001, 2003). In 2001, 53% of users aged 12-17 downloaded music files via P2P networks. In a related finding, students are also more likely to download music, with 56% of full-time students and 40% of part-time students reporting downloading music files to their computer. Only a quarter of non-students report downloading files.

In the United States Internet users' household income and educational level appear to be negatively correlated with downloading behaviour. For example, 38% of Internet users in households earning less than USD 30 000 a year download music files, as opposed to 26% of those earning more than USD 75 000 (Pew, 2003), and more highly educated Internet users seem less prone to download music. Specifically, 23% of Internet-using college graduates download music files as compared to 34% of Internet users with lower levels of education (Pew, 2003). However, it is important to recall that students, who are usually counted as low-income and who have not yet completed their degree, are the most active file-sharing users.

For France, for instance, the negative relationship between P2P use and income cannot be confirmed (Table 5.10). French students and managers (*cadres*) are most likely to download. French Internet users aged 18-24 are the most active P2P users, followed by users under 18 years and those aged 25-39. As the current generation of P2P users moves into older age brackets, file sharing is likely to become widespread at all ages. With respect to income, blue-collar workers earning less than EUR 900 a month are as likely to download music as persons earning more than EUR 3 100 a month. In addition, Internet users with a university diploma are more likely to download music than those with a high school or no diploma. In general, men are more likely to download music than women.

Table 5.10. French Internet users having downloaded free music, movie or software files over P2P networks, June 2003

Percentage of all Internet users

		Yes	No
Gender	Male	37	60
	Female	23	72
Age	12 – 17 years	31	66
	18 – 24 years	47	52
	25 – 39 years	31	65
	40 – 59 years	22	74
	60 – 69 years	(11)	82
Education	No degree	(21)	75
	High school diploma	33	62
	University diploma	35	61
	Individuals between 12 and 17 years	31	66
Profession	Self-employed	(28)	70
	Manager or posts of high responsibility	37	58
	Employee	26	69
	Blue-collar worker	31	67
	Retired	(14)	72
	Student	36	61
Monthly household income	Below EUR 900	36	60
	EUR 900 to EUR 1 500	28	67
	EUR 1 500 to EUR 2 300	31	64
	EUR 2 300 to EUR 3 100	27	69
	Above EUR 3 100	35	60

Figures in brackets may not be statistically meaningful and should be interpreted with caution.

Source: CREDOC (2003), "La diffusion des technologies de l'information dans la société française", Document réalisé à la demande du Conseil Général des Technologies de l'Information et de l'Autorité de Régulation des Télécommunications, Novembre, www.art-telecom.fr/publications/etudes/et-credoc-2003.zip

New applications of P2P networks in research and business

P2P is not simply downloading of MP3 files. In fact, file sharing has already moved to the next level and will be applied for all types of on-line information, data distribution, grid computing and distributed file systems (USA Today, 2003; see also OECD, 2002). Some examples shall illustrate:

- In applying the P2P technology to Skype, a free, high-quality Voice over the Internet (VoiP) service that has diffused rapidly, another important driver of change in traditional telephone markets may have been kicked off by the use of P2P technology.[7]

- Furthermore, banks already use file-sharing technology to transfer data to branches; in future, P2P platforms will be used for sharing proprietary information and distributing data for banking, insurance and other industries.

- Contiki, a travel service group, and Akamai, which provides e-business infrastructures, use P2P technology to help companies deliver sales presentations and multimedia content.

- The Linux company Lindows is continuing its experiment to offer software via P2P networks at half the normal price from its Web site, passing on lower networking costs to customers and increasing the number of simultaneous downloads.[8]

- P2P file sharing is also used in academia and government. Recently Penn State and MIT in the United States and British Columbia's Simon Fraser University in Canada started developing a P2P network to share academic materials faster and more reliably.

- The US government is using decentralised networks to exchange data,[9] and US federal agencies are reported have begun using P2P technology to get statistics and information from computers in over 100 different government agencies.

APPENDIX

Figure C.5.1. Change In Share of Global P2P User Base 2002 to 2003
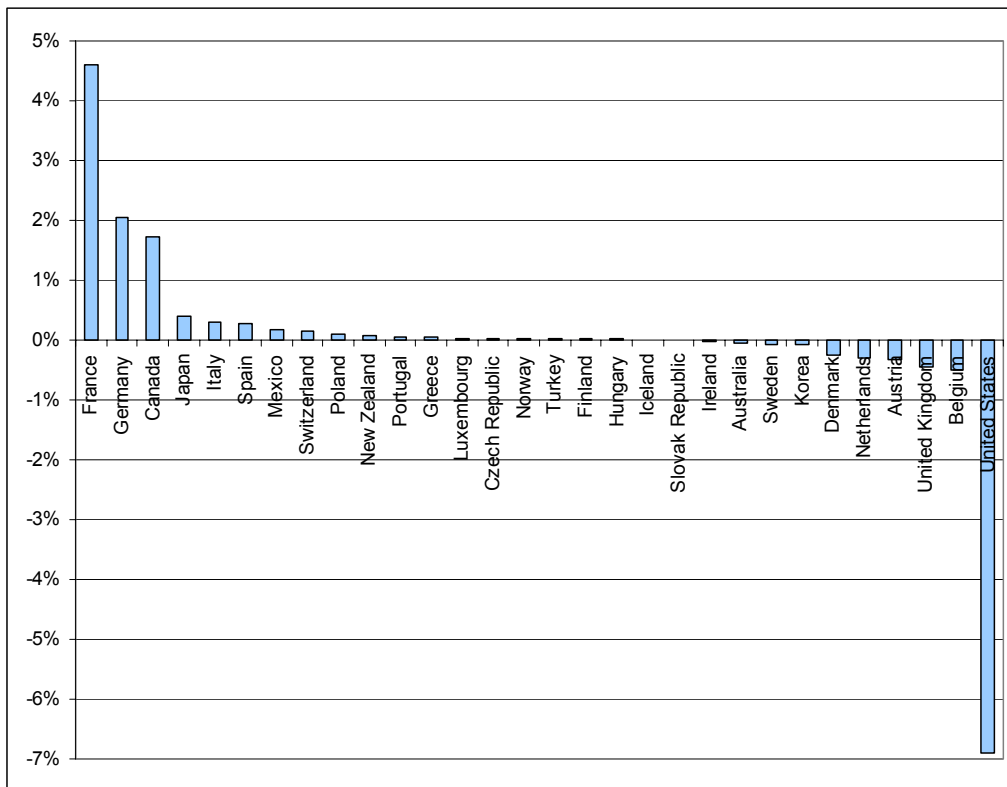
Source: OECD based on BigChampagne data. The strong growth rates for European countries, can be explained by the fact that P2P has become popular later than in, for instance, the US. As one would expect, countries with lower initial shares experience stronger growth.

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