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Questionnaire Study on Mobile Peer-to-Peer

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Acronyms

AAA	Authentication, Authorization and Accountability
BGP	Border Gateway Protocol
CDN	Content Delivery Network
FICORA	Finnish Communications Regulation Authority
fps	frames per second
FTP	File Transfer Protocol
GPS	Global Positioning System
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access
HTML	HyperText Markup Language
IM	Instant Messaging
IRTF	Internet Research Task Force
NNTP	Network News Transfer Protocol
P2P	Peer-To-Peer
P2PTV	Peer-To-Peer TeleVision
PGP	Pretty Good Privacy
POI	Point Of Interest
SSH	Secure Shell
TCP/IP	Transport Control Protocol / Internet Protocol
UMTS	Universal Mobile Telecommunications System
VGA	Video Graphics Array
VoIP	Voice over Internet Protocol
WiMAX	Worldwide Interoperability for Microwave Access

1 Introduction

1.1 Background

Mobile peer-to-peer technologies and applications are under extensive research in the academia. Content sharing using fixed Internet has been the most successive P2P application in the PC world, since over 50 % of the Internet traffic is produced by P2P file sharing (Ipoque 2007). Thus it is seen as one of the most promising applications also in the mobile domain albeit usage situations and terminal base are different in many ways.

Actually, mobile devices have many interesting properties that enable new kinds of use cases for content sharing. People carry always them contrary to laptops or not to speak of desktop computers. Mobility and built-in positioning systems make it possible to use location information in innovative ways. Additionally, mobile phones are constantly on and connected to the network whereas PC's are normally shut down or disconnected from the Internet when they are not used. Thus the content stored in the mobile phones is always accessible, which enhances the reliability of the P2P model.

Best of all, mobile phones are capable of creating content because of integrated cameras and sound recorders and text input possibility. Rapid sharing of, for example, photos would thereby be possible without the need to move the photos from the camera to the PC and upload them to some photo sharing service – the extra effort that often restrains sharing. As a very personal device originally designed to connect people, mobile phones have strong support for social relationships. Hence the social networking type of content sharing, where only friends or some group of people are given the access to the content located in a person's mobile phone, would be feasible, although it hasn't been implemented in today's popular P2P file sharing applications.

1.2 Research questions

To direct the research on right topics, better knowledge about people's interest in content sharing using mobile devices is needed. This study tries to offer insight on this issue. The focus is on the self-made content, not too much on the professionally created, copyright-protected material. The research question is stated as follows:

How interested are people to share different types of content with their mobile phones?

To make the topic more convenient to handle, following supporting questions are identified:

With whom are people interested to share content?

How large are the different social groups?

Are there some constraints that affect interest to share content using mobile phones?

1.3 Research methods

The research methods applied in this thesis are:

- Literature survey
- Web questionnaire

Literature survey is used to get understanding of the P2P content sharing model and different possibilities to share content. The main tool in answering the research questions is a web questionnaire, in which mainly multiple choice questions are asked.

1.4 Structure of the assignment

The organization of this assignment is presented in Figure 1.

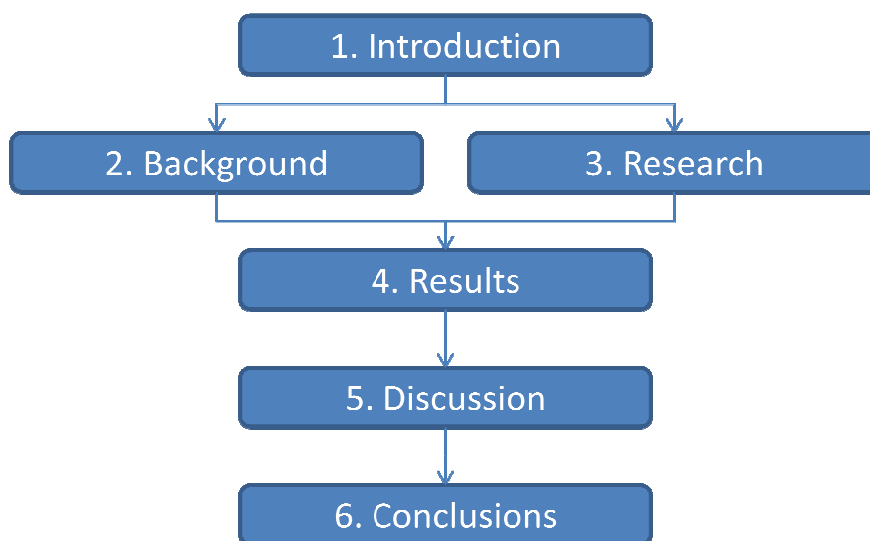


Figure 1: Structure of the assignment

This first chapter introduces the topic and explains the research questions. The second chapter offers necessary background information to understand terminology, mobile technology, content sharing possibilities, social networking phenomenon and P2P technology.

The third chapter provides information about researching mobile service and technology usage. Especially web survey as a research method is introduced. Web questionnaires as a special case are examined more deeply. Also the used platform and target group of the study are introduced.

The fourth chapter presents the results of the survey, which are then analyzed and discussed in the fifth chapter.

Finally, chapter six summarizes the key findings and suggests some topics for further research.

2 Background

2.1 Definitions

To understand the research questions, the definition of a few key terms is required. Especially words mobile, peer-to-peer and content need some clarifying.

According to Cambridge Advanced Learners Dictionary (Cambridge Advanced Learner's Dictionary) *mobile* refers to something “able to move freely or be easily moved” or it is “a telephone which is connected to the telephone system by radio, rather than by a wire, and can therefore be used anywhere where its signals can be received”. In this study mobile stands for a mobile phone.

Peer-to-Peer is a more complex term, which may as well be understood philosophically or technically. Kalevi Kilkki (2005) gives Peer-to-Peer a human definition as “an ideology in which peers interact with each other by offering their own resources for other peers to achieve common goals”. Peer-to-Peer Research Group of IRTF has quite a technical view: “Peer-to-Peer (P2P) is a way of structuring distributed applications such that the individual nodes have symmetric roles”. The most suitable definition for this study is however presented by Schoder and Fischbach (2003): “P2P refers to technology that enables two or more peers to collaborate spontaneously in a network of equals (peers) by using appropriate information and communication systems without the necessity for central coordination”. More information about peer-to-peer is presented in chapter 2.5.

The word *content* replaces the word file throughout this study. In most cases the word content is used in the terms “downloading content” or “sharing content”. This means the same as downloading or sharing files. The point here is that the mindset is directed to the textual, audio or graphical information of texts, music clips, photos and video clips, not to the file formats. In many cases, e.g. in video streaming, the content is not even saved for later use. *Downloading* and *sharing* are frequently-used terms. Downloading is understood as copying content over Internet into a computer's (e.g. PC or mobile phone) memory and sharing as letting other people download the user's own content.

2.2 Mobile technology development

Mobile phones have really developed by leaps in recent years. The evolution from simple phones allowing just calling and sending SMSs to multimedia computers has been fast. Nokia's flagship model N96 has HSDPA, WLAN, 16 GB internal memory, 2,8" color screen, mobile television, 5 megapixel camera capable of VGA quality video with 30 fps, GPS, email and web browser with flash support (Nokia - N96 Specifications). Apple's much hyped iPhone introduced a user interface based on an intuitive touch screen (Apple). These features enable rich use of the mobile phone. Especially the content creation possibilities are highly interesting when mobile peer-to-peer is considered.

Adequate bandwidth is the necessity for introducing peer-to-peer services on mobile phones. Survey of Ficora (Viestintävirasto - Telepalveluiden käyttötutkimus 2008) reveals that 26 % of the Finns had 3G phone at the end of the year 2008. 3rd generation mobile networks enable data rates ranging from the theoretical maximum of 384 kbit/s of UMTS (both downlink and uplink) to HSPA's 14,4 Mbit/s (downlink = HSDPA) and 5,76 Mbit/s (uplink = HSUPA). However, actual data rates are normally much slower and thus differ slightly from fixed Internet connections. HSDPA is currently deployed by 203 operators in 94 countries and 127 operators support at least 3,6 Mbit/s data rates (GSM Association). For peer-to-peer traffic, large asymmetry in downlink and uplink speeds is undesirable. Thus implementation of HSUPA is very important to avoid uplink bottlenecks. So far 70 operators have committed to HSUPA including 55 operators commercially launched that (GSA - The Global mobile Suppliers Association 2008). Long Term Evolution of UMTS and WiMAX technology will improve data rates in coming years to match better new services – including mobile P2P.

Flat rate pricing has made extensive use of mobile Internet affordable. A data plan with unlimited data transmission (384kbit/s) can be purchased in Finland at as low-cost as 9,80€/month (DNA, Saunalahti). Saunalahti offers even a 5Mbit/s connection for 34,90€/month. Prices are comparable to fixed Internet prices for similar data rates. Tempting pricing has exploded mobile broadband penetration in Finland. Finns had at the end of June 2008 almost 310 000 mobile broadband subscriptions (Ficora 2008). Growth has been remarkable since the amount of subscriptions over doubled in 6 months.

2.3 Content sharing alternatives

Today's Internet offers a vast amount of possibilities to share content with other people. Different content sharing alternatives are compared in Table 1 below. They differ in respect of model of sharing and possibility to control access to the content. Sharing may be based on either sending the content to recipients or publishing the content on some media and allowing people to download content. Sending is usually more private and it allows access control more easily. However, it scales worse than publishing. Access control is categorized to private, restricted and public access. Some alternatives, basically send-based, are completely private, while others are totally public allowing anyone to reach the shared content. Using some kind of identification it is possible to restrict the access to only a subset of people. A few example services from each alternative are also listed.

Table 1: Different content sharing alternatives

Alternatives	Share mode	Access	Example services
Email	send	private	Gmail (Gmail), Hotmail (Hotmail)
Own webpage & blogs	publish	public	Blogger (Blogger)
File server	publish	restricted	FTP (RFC 959 - FTP)
Content sharing services	publish	public	Youtube (YouTube), Flickr (Flickr)
Social networking sites	publish	restricted	Facebook (Facebook), MySpace (MySpace), Irc-galleria (Irc-galleria)
One-click file hosting	send/publish	public	Rapidshare (RapidShare), Megaupload (MegaUpload)
Wikis	publish	public	Wikia (Wikia)
P2P networks	publish	public	BitTorrent (BitTorrent), Kazaa (Kazaa), Gnutella (Gnutella)
Instant Messengers	send	private	Skype (Skype), Windows Live Messenger (Windows Live Messenger)
Streaming	publish	public	Floobs (Floobs)

Email is a very personal way to share content. It works well only with small data amounts sent to a fairly small group of people. Instant messengers remind email in share mode and privacy. However larger file sizes are supported. Instant messaging happens between equal peers and thus IM-based file sharing is actually one application of peer-to-peer file sharing. Rapidshare-style of one-click web hosting services can be used to transfer large files and in

many cases it is used, when sending files as email attachments is inconvenient or impossible due to large file size. Although files are publicly available on one-click web hosting services, the links are hard to guess and they have to be shared by sending email or instant message; or publishing them on a web site.

A personal webpage can be used in various ways to share content. Different content sharing software packages can be installed and additionally content may be added using basic HTML. FTP and SSH are also ways to let people access larger amount of data located in a server. Many web services support or are made for content distribution. Picture sharing sites like Flickr or video sharing sites like Youtube are dedicated to some type of content and their main purpose is to enable content sharing. Social networking sites like Facebook or Irc-galleria add the social aspect to content sharing. In these services it is possible to restrict the access to content to only some subset of users, for example to own friends. Blogs and web page platforms offer ways to publish own content while discussion forums and wikis may be used communally.

The largest amount of data is shared in peer-to-peer networks. Especially music and video content is heavily present in P2P file sharing (Ipoque 2007). However, in the contrary to other alternatives, current P2P networks like BitTorrent or Gnutella are mostly used to share copyright protected, commercial content. Sharing personally created content like digital photos or video clips is much more unusual.

Commercial content sharing uses the same ways as private file sharing. Publish-based public sharing dominates and mainly the client-server model is used instead of P2P. One way to optimize content sharing is to use content delivery networks (CDNs). The content is replicated from the origin servers to replica servers and users are served by the closest replica server to minimize access delay and network bandwidth usage (Peng 2008). Akamai, founded in 1998, is one of the pioneers in CDN business (Dilley, et al. 2002).

2.4 Social networking

Social networking has risen as a huge phenomenon in recent years due to websites like Facebook, LinkedIn (LinkedIn) and MySpace. These websites allow people to connect with their friends, send messages, comment each others' doings – and share content. The

functioning of these sites is based on friendly relations. Friends' actions are linked to each other, which enables natural way of communication with those who are near to you. In social networking the distance of the people from each other is used as a tool. Most things are shared with direct friends, but also the concept of friends' friends is used. It is possible to explore friends' friend lists, search for dates among friends' friends or be founded by friends' friends for a job because of a recommendation of your direct friend.

Watts and Strogatz (1998) introduced the concept of Small World networks, which have three significant characteristics interesting to social networks: 1) relatively short average path length between networks members 2) relatively high clustering coefficient meaning that many friends of you are actually also your friends' friends and 3) they are scale free under power-law connectivity distribution (Xiaole 2003). A famous example of the small world phenomenon known as 'Six degrees of separation' claims that if a person is one step away from each person he knows and two steps away from each person who is known by one of the people he knows, then everyone is an average of six "steps" away from each person on Earth (Milgram 1967).

The effect of the small world can be understood more easily with some figures presented in the Table 2. It is assumed that every network member has same amount of direct friends and then four different values for this number is chosen. The effect is calculated only for the three first steps and the fact is ignored that most probably many friends have the same friends. However, the order of magnitudes match and interestingly having for example 100 Facebook friends means that you possibly have even 10000 friends' friends and a million friends of them.

When inspecting social networks, distance in steps is not the only way to describe people's relations. Social networks may be based on same interest which enables strangers beyond the first couple of steps of the six degrees model to communicate and share content. Interest may be hobby related but also workplace is potentially one common factor.

Table 2: Small world phenomenon

Direct friends	Friends' friends	Friends' friends' friends
2	4	8
10	100	1 000
100	10 000	1 000 000
300	90 000	27 000 000
n	n^2	n^3

2.5 P2P

Peer-to-peer networks (Figure 2) can be described by three characteristics: 1) shared provision of distributed resources and services, 2) decentralization and 3) autonomy (Subramanian 2005). Sharing of distributed resources means that each communicating node (peer) has both client and server capabilities – known also as servant concept (put together from terms server and client). Decentralization can be understood so that there is no central authority coordinating the organization of the network. Thus the nodes connect directly to each others. Due to the autonomy, every node can independently of each other choose when and to what extent it makes its own resources available to other nodes. Additionally, every node can initiate the connection (IRTF - Peer-to-Peer Research Group). Actually, the original Internet design can be classified as P2P network based on these characteristics (Oram 2001). Also some core Internet protocols like NNTP used in USENET servers and BGP, inter-domain routing protocol are actually P2P systems (IRTF - Peer-to-Peer Research Group). Nowadays peer-to-peer file sharing is the best known application of P2P, but it is not the only one. Other possibilities cover VoIP (Skype), instant messaging (ICQ), remote collaboration (shared file editing), distributed computing (SETI@home) and streaming media (P2PTV) (Beijar 2008).

Peer-to-peer is often compared to the other popular architecture called client-server. In client-server network (Figure 3) there is a functional distinction between clients and servers. Normally traffic flows from and to a centralized server, which responds to requests coming from many clients. Clients don't communicate directly with each other. Central

structure limits the scalability of the client-server model and makes it more vulnerable due to a single point of failure. Web servers and FTP are typical examples of client-server model.

When compared to client-server networks, P2P networks have some pros and cons. On one hand P2P networks provide better scalability, lower cost of ownership, self-organized and decentralized coordination of resources, greater fault tolerance (no single point of failure) and better support for building ad hoc networks (Subramanian 2005). On the other hand security mechanisms (AAA - authentication, authorization and accountability) are more difficult to implement in networks without central server and it is more difficult to guarantee availability in small networks.

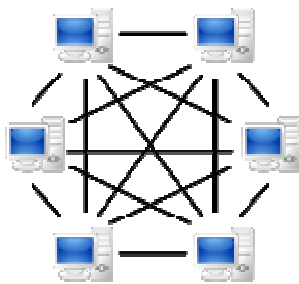


Figure 2: P2P network

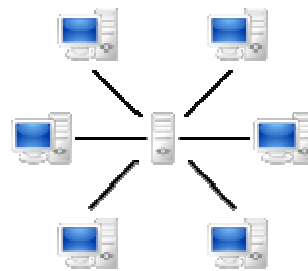


Figure 3: Client-Server network

Content sharing in P2P networks depends on voluntary participation of its users. Downloading and sharing content is free and every piece of digital content may be put available regardless of if the user has rights to the content or not. Thus P2P networks have potential for far larger amount of content and more copies of the same content than in web-based sharing. Especially the availability of commercial content for free has boosted the success of P2P file sharing.

On the con side, the free rider problem, where many people download content without contributing anything to the system, is *bête noire* to the P2P networking. A study concerning the Gnutella network (Adar and Huberman 2000) revealed that over 70 % of its users are free riding. Thus, many researchers have tried to find ways to insert incentives for cooperation to P2P networks (Golle, Leyton-Brown and Mironov 2001, Lai, Feldman, et

al. 2003, 2004). As a user acts both as a client and a server, running a P2P application uses computer capacity more than downloading or sharing the content through web. P2P requires special applications which need to be installed and searching content may be more cumbersome than finding it from a centralized web server. A study (Saroiu, Gummadi and Gribb 2002) has shown that most content-serving hosts suffer from low availability and have relatively low capacity network connections. Low availability relates especially to the less popular content, while low capacity network connections slow down the download rate compared to downloading from high capacity web servers.

2.6 Mobile P2P

Mobility and mobile phones bring new possibilities for using peer-to-peer networking. Since file sharing is a dominant application in the fixed Internet, context information including user's location, habits and friends may make other uses at least as important in the mobile domain. Mobile phones are "always on, always with", which makes it possible to use peer-to-peer networking also in that kind of applications, where real-time access is important (Bejar 2008). Built-in cameras enable instant sharing of user-created photos and videos, which is not the case with PC's.

Bringing P2P applications designed for PC usage to mobile phones is not easily done. A BitTorrent client called Symtorrent (Symtorrent) and a Gnutella client called Symella (Symella) exist, but they have been created as university projects and they most likely have only a petty amount of users. The reasons for this follow partly from the more modest device capabilities and partly from the mobile access. Mobile devices have less data storage space and their CPU performance is worse than PC's. Searching and consuming content, especially on the tiny screen, is not as delightful experience as using large PC screen. Mobile devices are battery-powered, which restricts the operation time. Mobile access networks have limited bandwidth and tighter operator control. These properties mean that widely used P2P applications and protocols have to be redesigned (Bejar 2008). For example searching algorithms are under heavy inspection (Ding and Bhargava 2004), since bringing search traffic to mobile terminals does not scale (Bejar 2008). Bandwidth usage optimization and bypassing firewalls and NATs are other issues of interest.

3 Research

3.1 Methodology

Studying usage and interest in technology can be implemented in numerous measurement points with many data collection methods. When mobile services are considered, there are three types of measurement points: end users, usage monitoring systems in mobile terminals and network nodes (Kivi 2009). Surveys and panel studies are the primary methods to gather data directly from real end-users. Also manual observing may be used, although sample size is limited compared to surveys. The greatest advantage of observing is that the information is gathered at the same time with usage, while surveys are based on earlier usage or expectations on future use (Heikkilä 1998).

Measurements and monitoring in end user devices or in network nodes are exact methods, where the real usage of services can be examined. Monitoring in mobile terminals can be arranged either manually, for example by using cameras to record display, keyboard, user's face and surroundings (Kaikkonen, et al. 2005), or by automated logging. Verkasalo and Hämmäinen (2007) used monitoring software for the Symbian S60 platform to study mobile phone usage of more than 500 mobile subscribers. Traffic measurements in intermediary nodes between terminals and servers using TCP/IP traces and server log files are yet another ways to study usage of mobile services (Kivi 2009). These methods enable the largest coverage because many users can be examined in the same measurement points. For example, when studying mobile Internet usage in Finland by collecting TCP/IP headers, Kivi (2006) was able to cover about 50-60 % of all Finnish mobile subscribers. Secondary sources, like expert interviews and market research companies' reports, may also provide explanatory information. To get better coverage, a combination of different measurement points and methods can be used.

3.2 Survey

When expectations and interests in new, not yet existing technologies are studied, survey is the only option. Because of quite the fast and inexpensive implementation they are widely used. A survey can be implemented using, for example, telephone, postal mail, e-mail, web, and various face-to-face questioning methods. These implementations can be divided in

interview surveys (face-to-face methods, telephone interviews), where researcher is actively immanent, and in self-administered surveys (postal mail, e-mail, web), where the researcher has no direct contact to respondents during answering. Advantages and disadvantages of questionnaire-based surveys are listed in the book of Robson (2002). Just to mention a few, self-administered surveys are relatively simple, straightforward, easy to implement, cost-effective and allow anonymity. On the other hand, the data is affected by respondents' memory, motivation and personality; there is a possibility for social desirability response bias; they have typically a low response rate; and ambiguities in the questions may not be detected.

When conducting a survey, the sample size and sampling method are essential for reliability of the results (Heikkilä 1998). The sample must be enough large and representative in order that the results can be generalized to the whole population. Questionnaire construction is another critical issue, and even an expensive study may be ruined by badly designed questionnaire form. Questions should flow logically from more general to more specific, from the least sensitive to the most sensitive and from factual and behavioral questions to attitudinal and opinion questions (Robson 2002). It must be ensured that the answer to a question is not influenced by the previous questions. The amount of open-ended questions should be kept small, because they are laborious to process and are often skipped by respondents.

3.3 User research on mobile P2P

User research concerning mobile P2P is in its infancy. This can be reasoned by the lack of existing mobile P2P applications. Thus measurements and research based on the actual use of mobile P2P services is not possible. The only reported study in scientific literature about mobile P2P users and their attitudes is the predecessor (Matuszewski, et al. 2007) of this study. 98 students of the Helsinki University of Technology responded to various questions concerning current usage of P2P applications with PCs, interest in downloading and sharing content with their mobile phones and the effect of social groups on these interests. Also a couple of possible mobile P2P applications were sketched and respondents' opinions were asked. Part of the questions in this study has been taken directly from the earlier study.

Survey (Hietanen, Huttunen and Kokkinen 2008) of Helsinki Institute for Information Technology (HIIT) in the summer 2007 concentrated on copyright issues and legal aspects of P2P file sharing. On the basis of over 6000 responses the study suggests that P2P users are aware that they are breaking the law and find illegal file sharing as morally wrong, but the risk of getting caught is considered negligible. However, the most interesting results for this study are those received in background questions. For example the different ways to download files and the frequency of P2P usage were asked. Other interesting studies concerning P2P usage cover themes like general peer-to-peer behaviour and file pollution dynamics (Lee, et al. 2005, Pauli and Shepperd 2005), social factors affecting user's decision to share (Mannak, Ridder and Keyson 2004) and reward systems affecting user behaviour (Cheng and Vassileva 2005).

3.4 Target group

The survey was implemented as a web questionnaire, which was available from 5.5.2008 to 9.6.2008 both in English and in Finnish. The main target group consisted of telecommunications technology students at the Helsinki University of Technology, who presumably are early adopters of novel mobile applications. Participants of a course on signalling protocols were encouraged to answer the questionnaire rewarding them with an extra exam point. The questionnaire was also advertised through news groups and mailing lists of Department of Communications and Networking. Personal emailing was used to invite people with different educational background.

3.5 Survey application

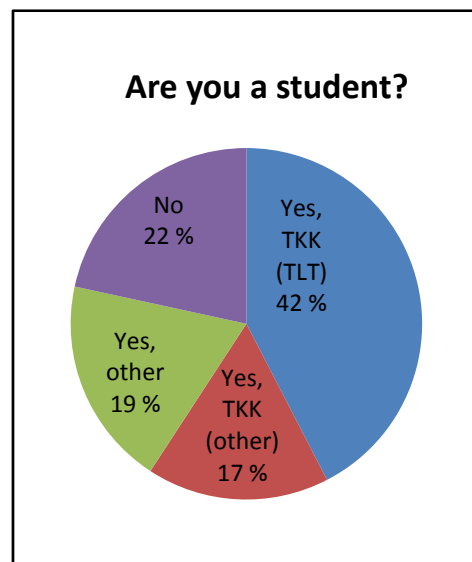
Executing a web questionnaire required a survey application. Based on a brief review of alternative applications an open source survey application called LimeSurvey (Limesurvey) was chosen. It is written in PHP and stores surveys and answers on a database. It offers a rich feature set ranging from conditional questions to support for multilingual surveys. Versatile online tools enable quick examination of results while comprehensive set of exporting file formats makes it possible to use the most popular statistical programs as well as Microsoft Office Excel in deeper analysis.

4 Results

4.1 Demographics

The questionnaire was answered by 125 persons. The sample embodies mostly Finnish males between 22 and 28 years old. The majority of the respondents (78 %) is still studying, although almost as many (72 %) are working part- or full-time. Due to the high response rate among participants of the Signalling protocols course, over 40 % of the respondents study telecommunications technology (TLT) at Helsinki University of technology (TKK) (Figure 4). The characteristics of the surveyed sample are summarized in the Table 3.

Male	78 %
Student	78 %
Employed	72 %
Finnish	75 %
15-21 years old	7 %
22-28 years old	85 %
29 or older	8 %



4.2 Mobile phone usage

The respondents' mobile phone base and usage was studied in order to understand the readiness to start using mobile P2P services and applications. All the respondents excluding one person have a mobile phone and half of them (48 %) have a 3G phone. The popularity of 3G phones is twice as much as reported in the study of FICORA on usage of telecommunications services in 2008 (Viestintävirasto - Telepalveluiden käyttötutkimus 2008), which was anyway expected when target group of tech students was chosen. Only

22 % of the phone owners (40 % of the 3G phone owners) have a flat rate pricing for data transfer. Still, 85 % of the flat rate owners have also a 3G phone.

Figure 5 shows how large proportion of the phone owners has used different features of their mobile phones. The results are presented for three different groups: 1) All phone owners, 2) Respondents who have 3G phone and 3) Respondents who have flat rate pricing for data transmission. Camera, calendar, music player and web browser are familiar to more than 60 % of the respondents. Also about half of them have downloaded ring tones and read emails with mobile phone.

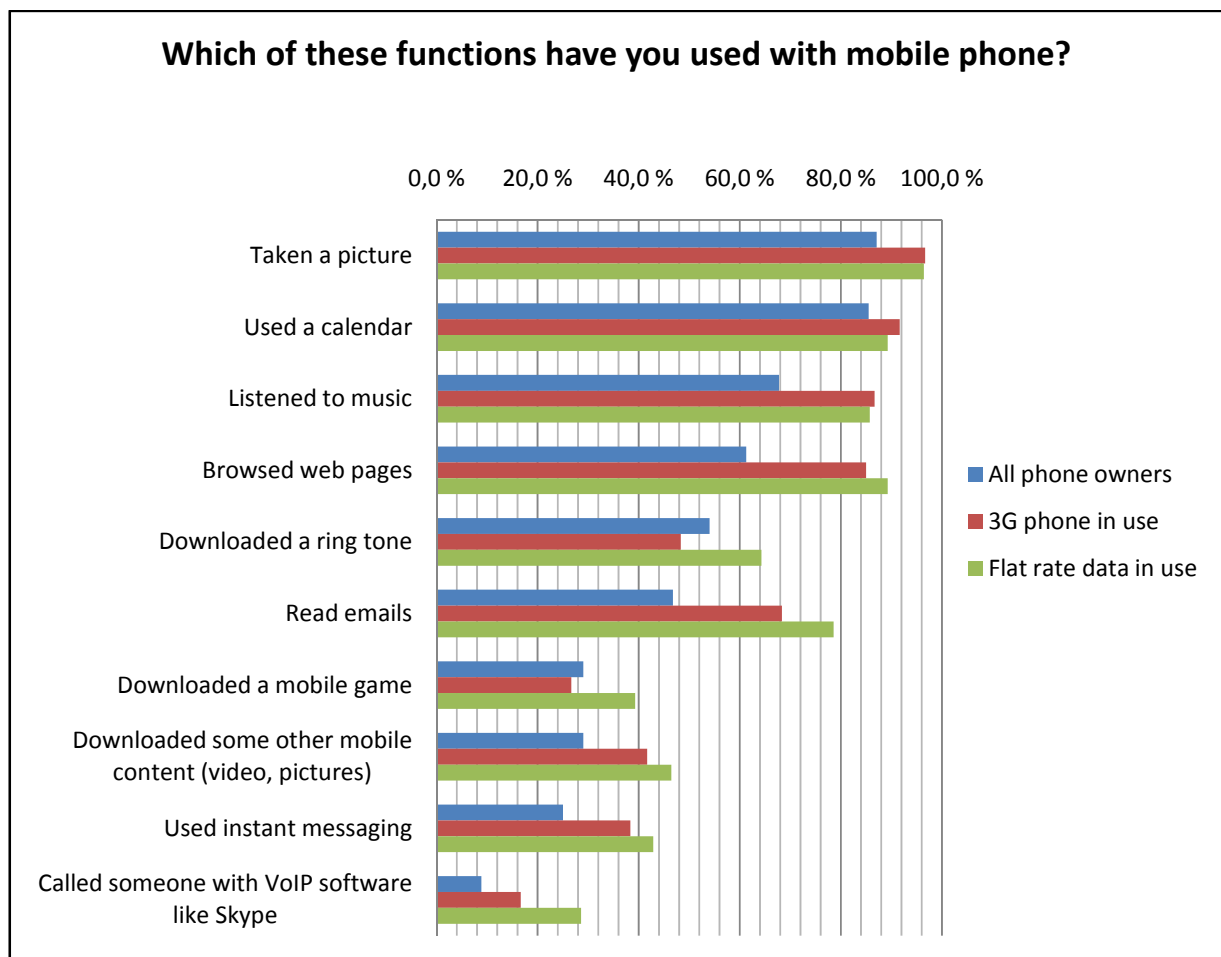


Figure 5: Mobile phone features used by respondents

Having a 3G phone or flat rate data subscription increases the usage of most features. Especially respondents with flat rate data seem to be using their phones more versatile

than others. Expectedly, usages involving intensive data transfer like web browsing, instant messaging, reading emails or using VoIP software are much more typical when user has a flat rate data subscription.

Figure 6 presents respondents content creation activity. As already Figure 5 showed, most of the respondents have used camera and calendar on their mobile phones and over 50 % of them are fairly active, indicating they have created over 20 photos and calendar notes. Recording video clips seems interesting, but only 14 % have recorded over 20 of them. Writings (exemplified as news, blog posts, discussion forum posts but not SMSs nor emails) differ from other content types, because only 9 % of the respondents have created them using a mobile phone and 58 % are not even interested in creating them. This can partly be reasoned by the rather inconvenient text input methods available in today’s mobile phones and partly by the long duration of writing an article.

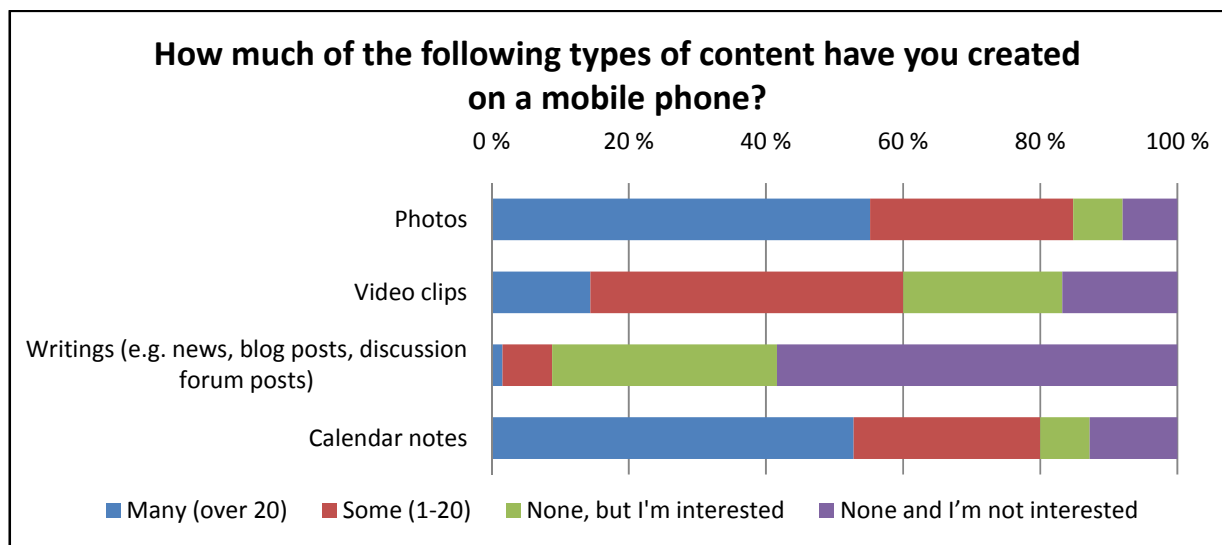


Figure 6: Content created on a mobile phone

4.3 Content sharing using fixed Internet connection

Respondents’ content sharing experiences using a fixed Internet connection were asked based on different content types. Photos were the most shared content type with 78 % of the respondents having shared them. 75 % of photo sharers have also restricted access so that only a limited group of people can see their photos. Thus it is justified to claim that the possibility to set access rights is a necessary requirement for content sharing applications.

A list of different photo sharing applications was presented to the respondents and their usage history was asked. Facebook and an own webpage were the most well-known applications. Interestingly those are multipurpose applications contrary to many dedicated photo sharing services. One reason for this - especially when thinking Facebook - may be that it allows commenting and linking persons to photos, which adds social aspect to photo sharing. Unfortunately email was missing from the list although it probably is one of the most popular ways to share small amount of photos. Despite this nobody mentioned email in the 'Other' category, which contained mostly dedicated photo sharing services (Kuvat.fi, BayImg) or social networking sites (hi5, Orkut).

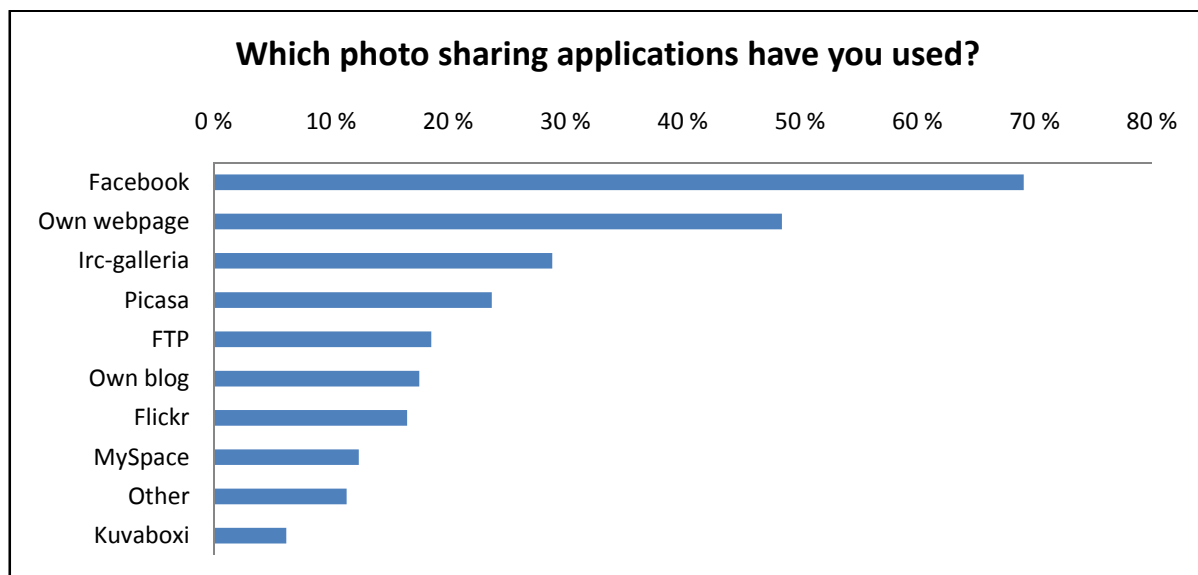


Figure 7: Photo sharing applications used by respondents

Respondents were not too familiar with video sharing. Only 22 % of them had shared their video clips on the Internet. One third of respondents had written a blog post and 78 % participated in discussions on web forums (41 % monthly or more often). Detailed information about respondents' web forum usage can be found in Figure 8. Judging by these results participative presence in the Internet is quite common for respondents.

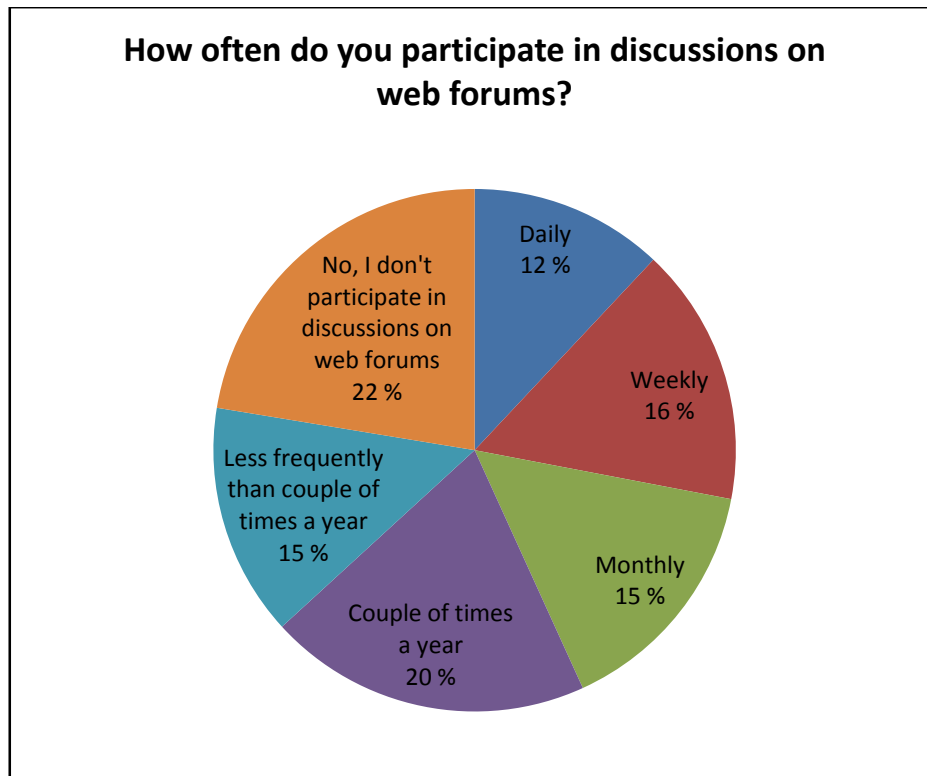


Figure 8: Activity in web forum discussions

4.4 P2P file sharing

The P2P file sharing concept is understood by 93 % of the respondents. 49 % also have some technical understanding about peer-to-peer technologies, which doesn't come as a surprise since majority of respondents study engineering. Nine of ten respondents have downloaded and two thirds have also shared content using peer-to-peer applications. However, only 20 % of respondents have been first sharers of some content. Nevertheless that is much more than in the HIIT study from year 2007 (Hietanen, Huttunen and Kokkinen 2008), where only 9 % reported being the first file sharer of music, movie or TV series files. It must anyway be kept in mind that the target group of that HIIT study was much broader.

Due to a mistake in the questionnaire logic, the questions concerning P2P applications, typical duration of a P2P session and frequency of using P2P applications were asked only from the respondents, who had both downloaded and shared content using P2P

applications or didn't know if they had. This group covers 67 % of respondents. The most commonly used applications among this group are listed in Figure 9.

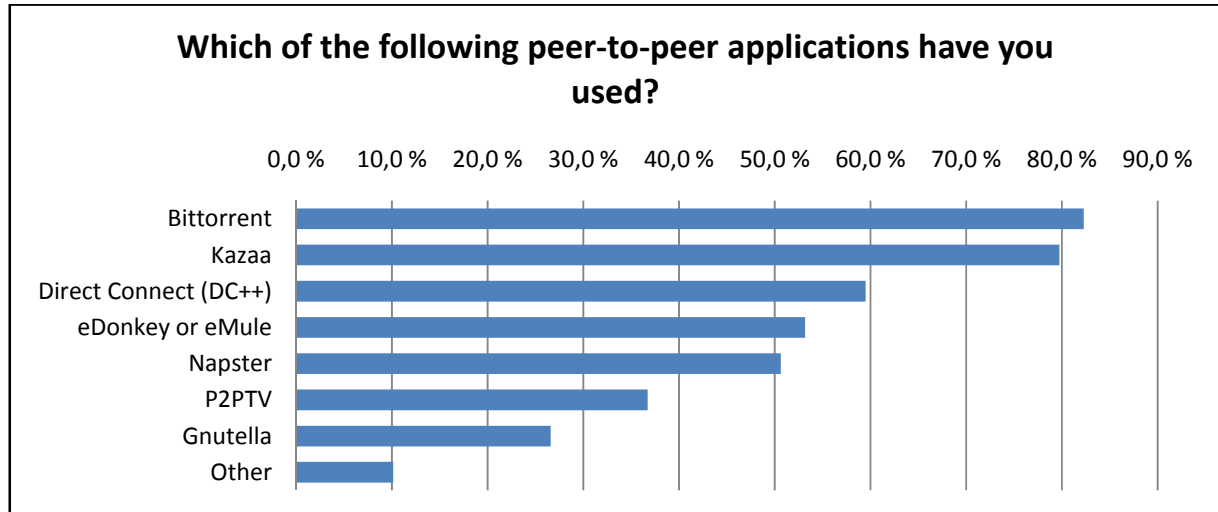


Figure 9: Most popular P2P applications among experienced users.

BitTorrent and Kazaa (FastTrack protocol) were clearly the most popular applications. Interestingly over 50 % have also used Napster (Napster), the seminal P2P file sharing application, which really brought P2P file sharing to everyone. Watching television programs in peer-to-peer fashion was surprisingly well-known with 37 % of these active users having tried that. The "Other" category contains mostly other file sharing applications for PC. Only one respondent had used Symella or Symtorrent, which are clients for using Gnutella and Bittorrent networks with Symbian smart phones.

In spite of the communal nature of the P2P concept users don't normally have strong incentives to act altruistically. Most peer-to-peer users namely keep their P2P applications open only when they are downloading some content (Figure 10). Figure 11 presents the frequency of using P2P applications. Usage is fairly active since 7 % of the users use them daily and 34 % weekly.

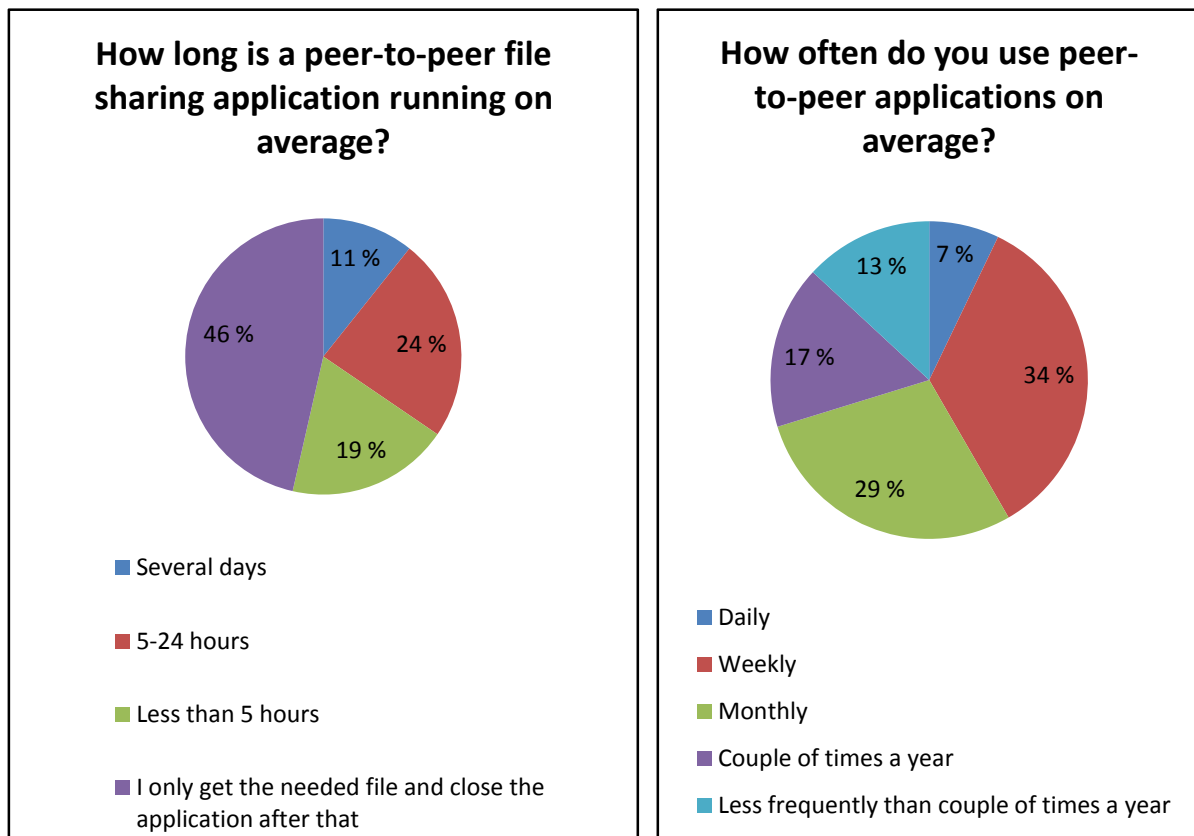


Figure 10: Duration of a normal peer-to-peer file sharing session **Figure 11: The frequency of using P2P applications**

Respondents' thoughts about usefulness of peer-to-peer applications in mobile phones are presented in Figure 12. Attitudes towards mobile P2P are promisingly positive since 76 % of the respondents think that mobile P2P applications could at least sometimes be useful. However, only 7 % find them very useful. This may be explained by that, that there aren't any notable applications available yet and thereby it might be difficult to imagine the possibilities. The result can also be interpreted so, that possibly the same kind of applications that succeeded in fixed Internet may not be the right ones in mobile domain. Many respondents expressed their concern about possibly poor usability of applications due to small screen size, short battery life and lousy performance of mobile phones. Interestingly background of using P2P applications on fixed Internet doesn't affect respondents' opinion when compared to non-users. On the contrary, engineering students see mobile P2P applications more promising than other respondents.

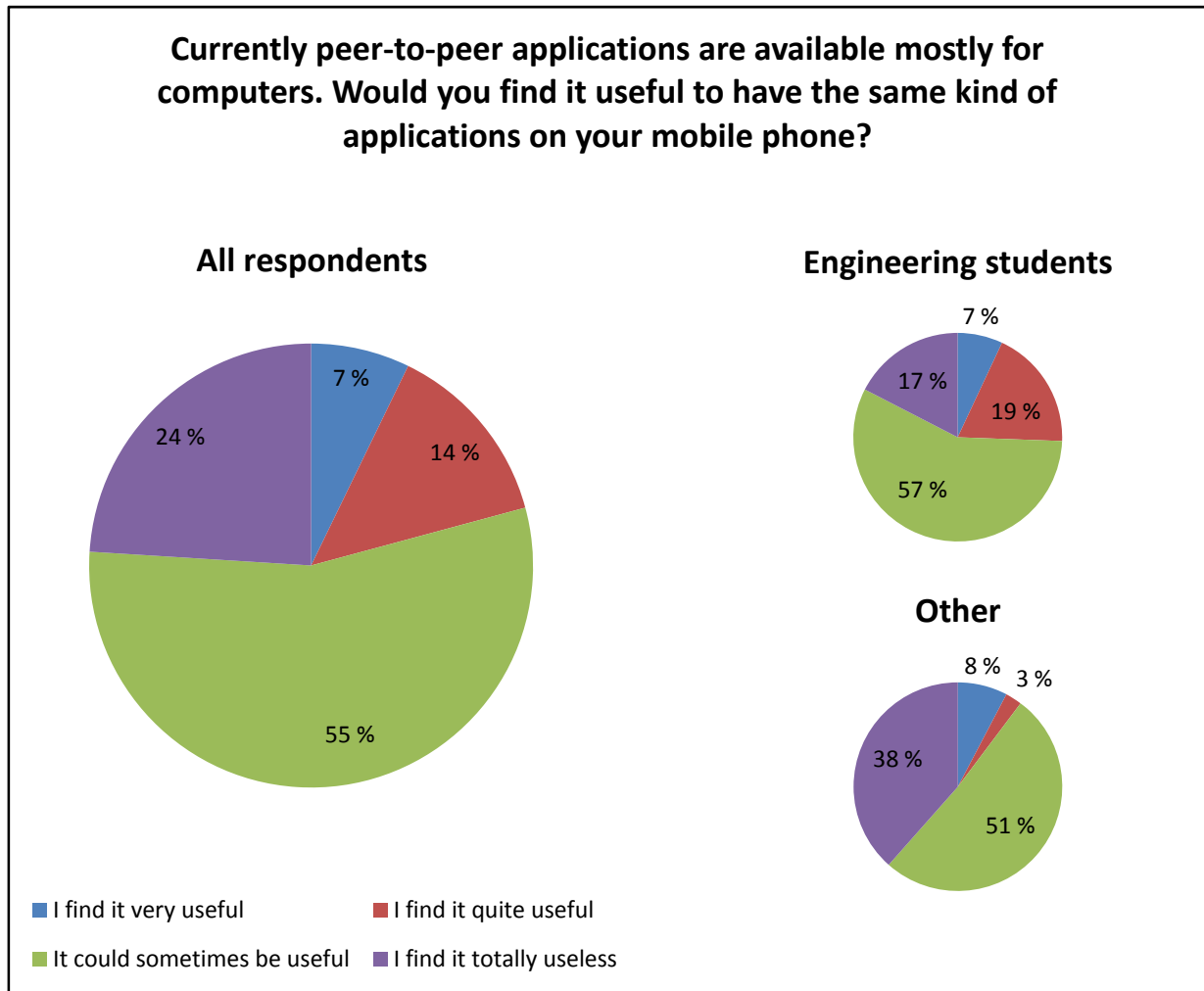


Figure 12: Usefulness of mobile P2P applications

Respondents brought out some interesting use cases, where content sharing directly between mobile phones could be useful. This was surveyed in an open question before interest in downloading and sharing content with mobile phone was asked in detail. Sharing own photos and video clips between friends came up most frequently. Mobile clients for using existing P2P networks to download music were another wish of many respondents. Live video streaming was seen as a good possibility to fulfill long tail needs (Anderson 2006) such as broadcasting regional league sports events or university lectures to those who cannot attend. Location based information was seen as especially suitable to be changed directly between adjacent mobile phones. For example updating maps of a GPS application and live reporting of car accidents were brought up. Couple of respondents

remarked that Bluetooth and infra-red can already be used to share content directly between mobile phones. One respondent proposed that distributing keys of a reliable security mechanism like PGP could be implemented directly between phones.

4.5 Interest in downloading and sharing content with mobile phone

Figure 13 presents respondents' interest in downloading different content types created by other users. Especially notable is the high interest rate for maps and POIs (Point of Interest, a specific geographical location that someone may find useful or interesting). Over two thirds of the sample were either very or quite interested in downloading location information. Also photos and video clips, which are typical content types shared today, seem to be interesting to about half of the people.

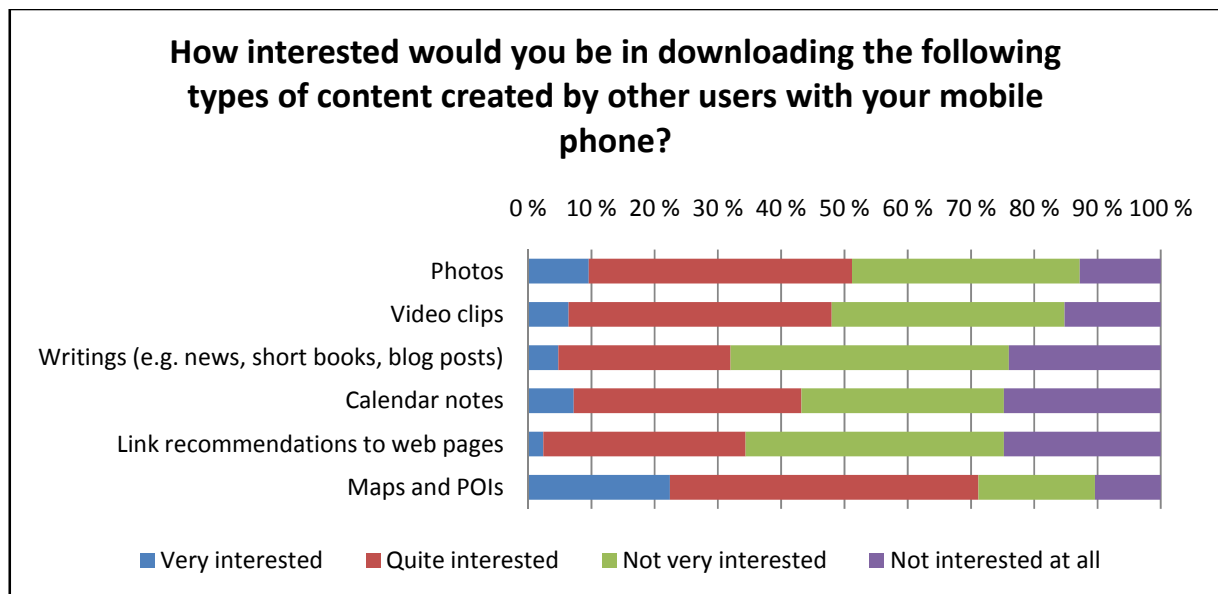


Figure 13: Interest in downloading content created by other users

Also interest in downloading professionally created content was asked (Figure 14). Comparing these results to those in Figure 13 shows no huge differences. Here we note high interest in downloading music. However, maps and POIs are still the most interesting content type. Professional quality of commercial content providers is appreciated in video clips and writings, which can be seen in little bit larger percentages in "Very interested"-category. Yet personality seems to be valued in the photos, since user created photos win

content provider created pictures – especially when “Quite interested” categories are compared.

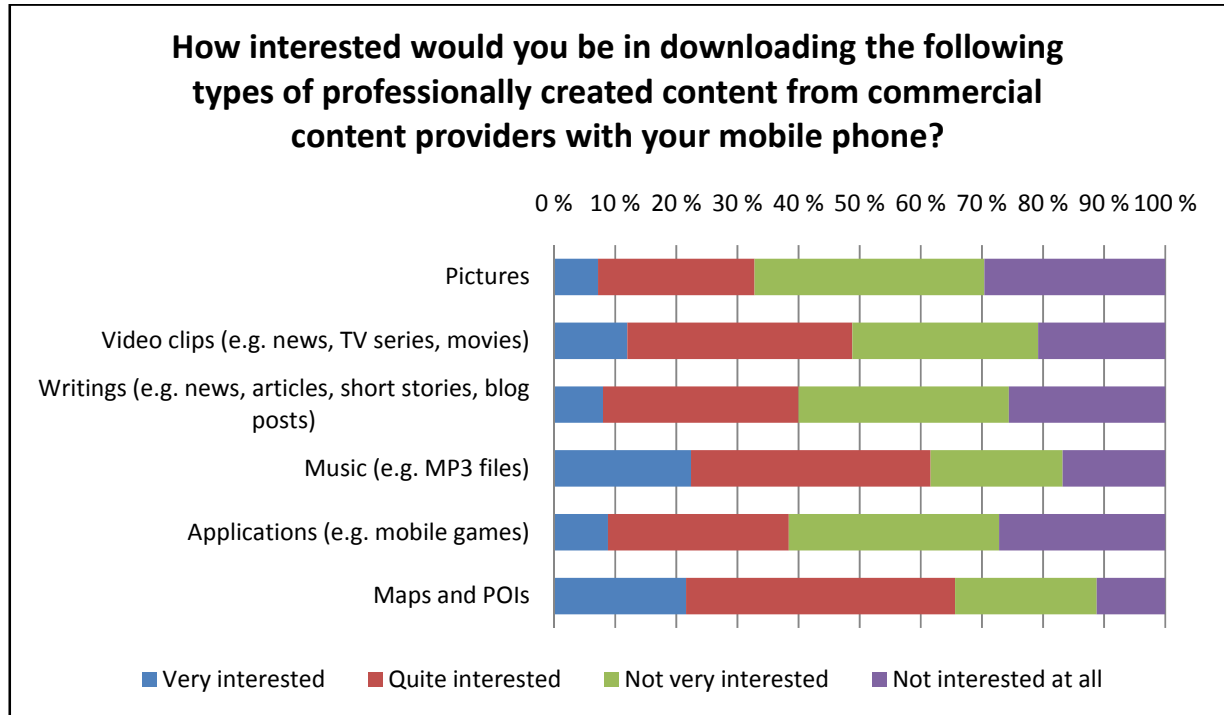


Figure 14: Interest in downloading content created by commercial content providers

Figure 15 presents interest in sharing different content types. Sharing content was seen less attractive than downloading in all categories. Maps and POIs have the highest rates (7 %) in “Very interested”-category. This is still far less than in downloading the same content type (22 %). Photos were the second most interesting content type. Own writings were considered a rather uninteresting content type to be shared. This can be reasoned, because only a few have even created writings (see Figure 6) with their mobile phones.

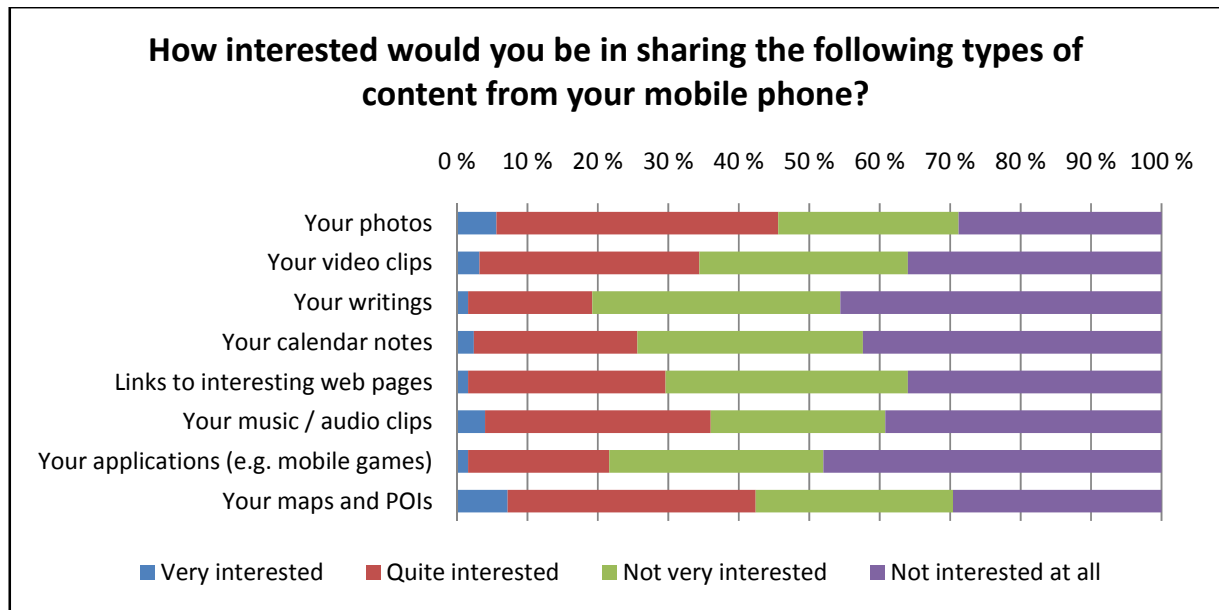


Figure 15: Interest in sharing different content types

Influence of content sharing experience and demographics on interest to download (Figure 16) and share (Figure 17) content with mobile phone was also examined. To ease the study, only photos were taken into account. The assumption was that the interest to download and share photos correlates positively with the experience on sharing photos on the Internet. This proved to be true and especially the share of most negative answer option “Not interested at all” is over two times smaller when photo sharers are compared to non-sharers. Respondents studying engineering were clearly more interested in downloading photos to their mobile phones. Interestingly the interest in sharing is somehow divided. Engineering students are overall more interested in sharing photos, but the rate of very interested is smaller than among other respondents. This may reflect engineering students’ better knowledge of security and privacy issues concerning content sharing directly between mobile phones, which may lower the interest to share content. Also age was considered as a possible variable, but the respondent corps was too homogeneous in that sense and no good grouping was possible to make.

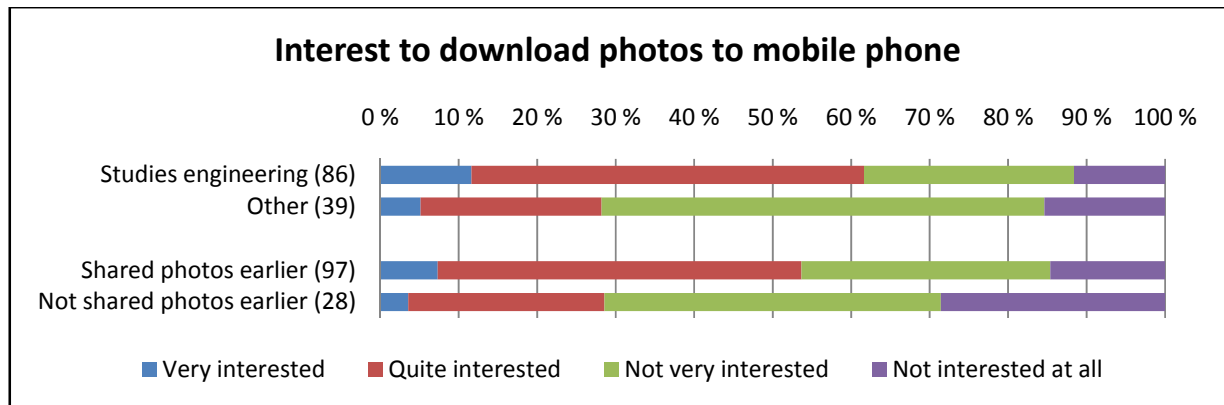


Figure 16: Interest to download photos to mobile phone based on experience and education

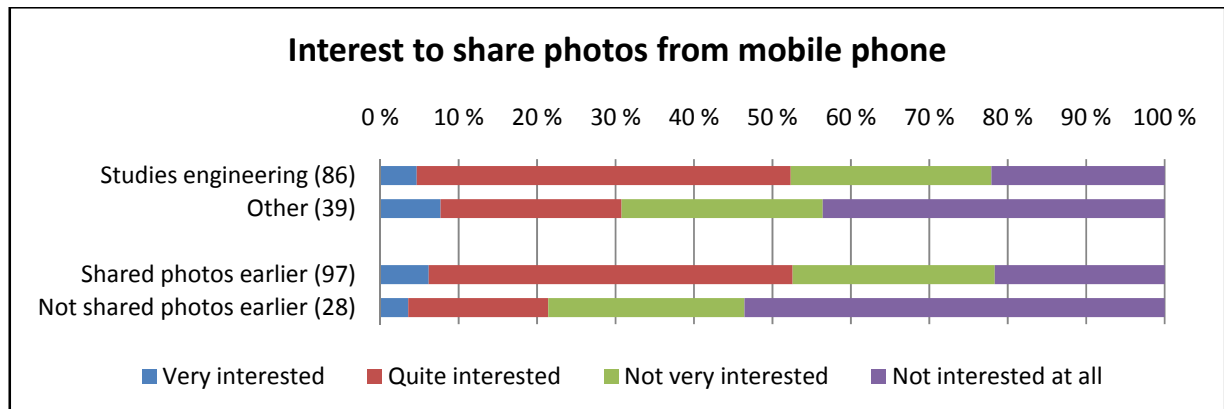


Figure 17: Interest to share photos from mobile phone based on experience and education

4.6 Significance of social networks

The willingness to download and share content was also asked based on different groups of people (Figure 18 and Figure 19). Three first groups – Family and friends, Friends’ friends and Unknown people – differ clearly in respect of closeness to the respondent. This can also be seen in the results, which show obvious correlation between the distance of the group and interest in downloading or sharing content. Almost 80 % of the respondents have positive attitude (very or quite interested) towards downloading and sharing content with their family and friends when only a small fraction of respondents show interest doing the same with unknown people.

Two special interest groups - study/work colleagues and leisure-related groups - were taken under inspection. Study/work colleagues are normally well-known by the people,

although the social ties may not be as strong as with family members or friends. Thus it is not a surprise that this group has the second highest rate of interest. Leisure-related groups are defined quite vaguely and may as well contain small and very close communities (like respondent’s own football club) as larger, disjoint groups (like world-wide fan club of a football team). However, common interest group increases willingness to download and share content when compared to totally unknown people and in some extent to friends’ friends too. Generally speaking interest to download content is higher than interest to share. Nevertheless, the difference is smaller when the people are well-known and larger when they are not.

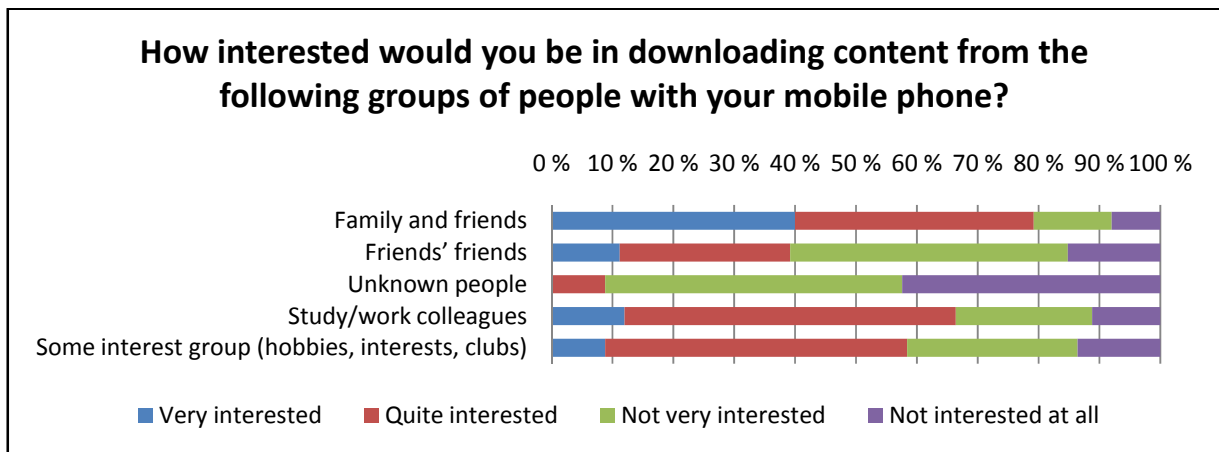


Figure 18: Interest in downloading content from different groups of people

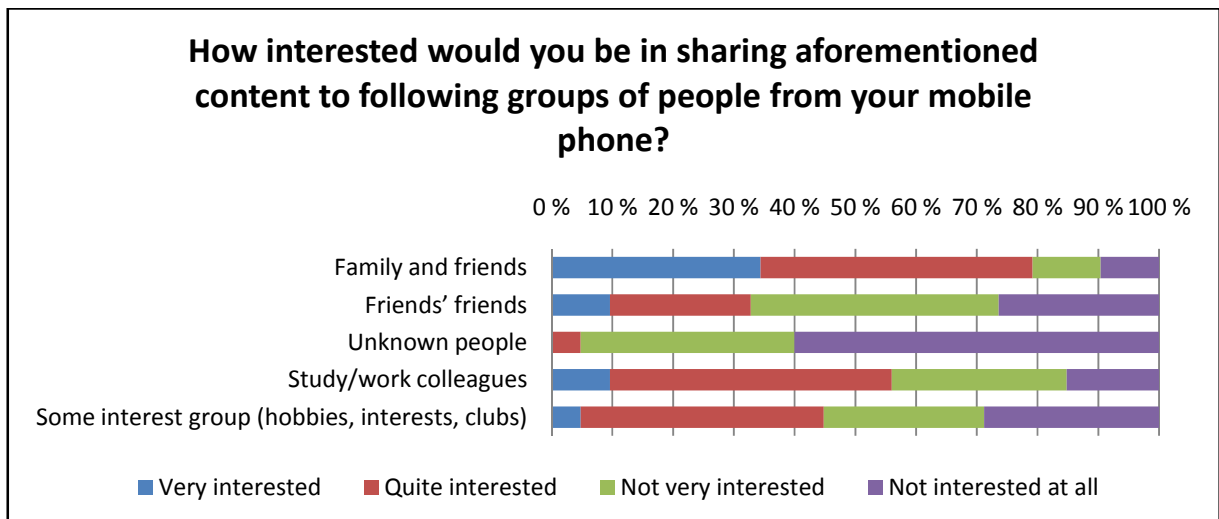


Figure 19: Interest in sharing content to different groups of people

The sizes of different social groups were asked in order to understand better the dynamics of the groups. The results are presented in (Figure 20). Because of vague definitions of terms “family”, “friends” and “study/work colleagues” the results are open to interpretations. However, the median value for the number of family members was five persons and number of friends and study/work colleagues 20 persons both. Altogether the results of friends and study/work colleagues resemble each others. Also the number of phone book contacts was asked. Median value was 120 contacts, but the answers range from 0 to 1600 contacts.

Group formation was seen as an interesting possibility, although most of the people would participate actively on 5 or less groups (Figure 21). The theme for the most important group was asked in an open question. The results were categorized afterwards into six classes (Table 4). The table shows that the theme for the most important groups would often relate to hobby, sports or music. The size of this most important group varies largely. The median size of the group is 20 persons, but some respondents identified groups that could contain more than million persons. Themes in these groups were very broad (e.g. porn, fishing and cars).

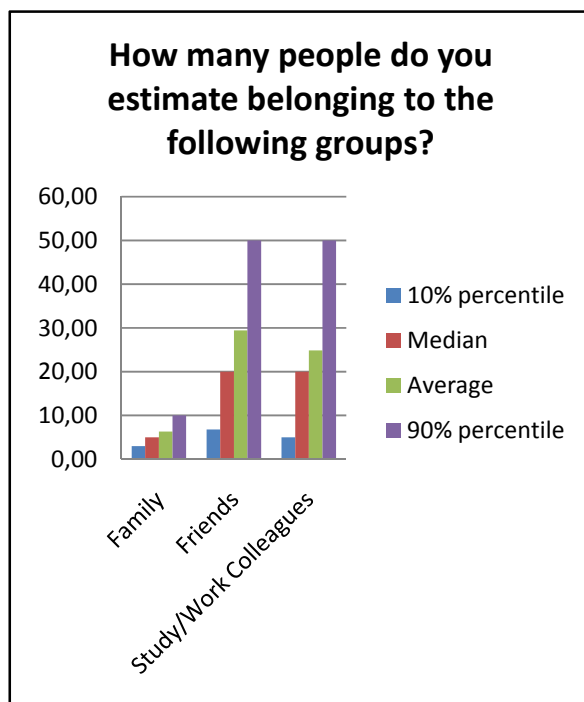


Figure 20: Number of people belonging to social groups

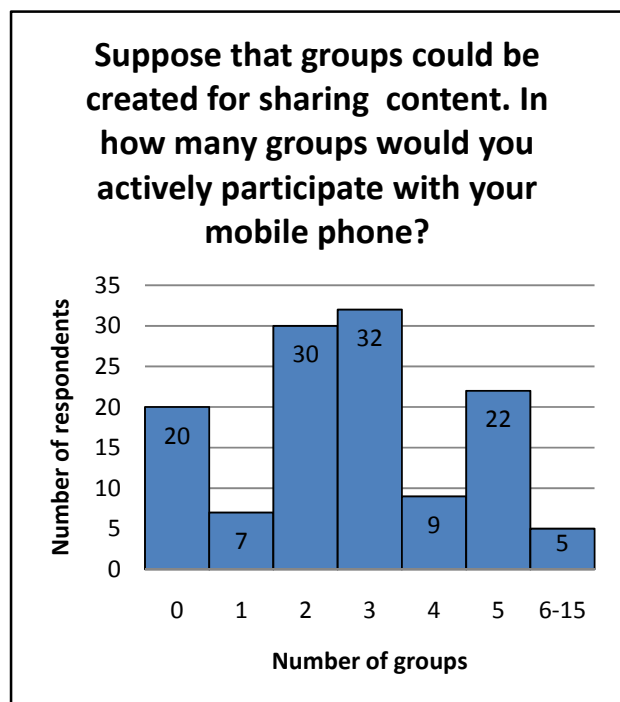


Figure 21: Distribution of number of actively used groups per respondent

Table 4: Theme of the most important group

Theme	Nr. of respondents
Hobbies & spare time	27
Sports	24
Music	19
Friends & family	12
Work	4
Porn	3

4.7 Constraints affecting mobile content downloading and sharing

New applications or services may have costs that prevent potential users from starting to use them. Thus respondents were asked to judge a couple of possible constraints using a 5-step scale where one end was “would not reduce my willingness to download/share” and the other was “would prevent me from downloading/sharing”. Answers to willingness to download are compiled in Figure 22 and answers to willingness to share in Figure 23.

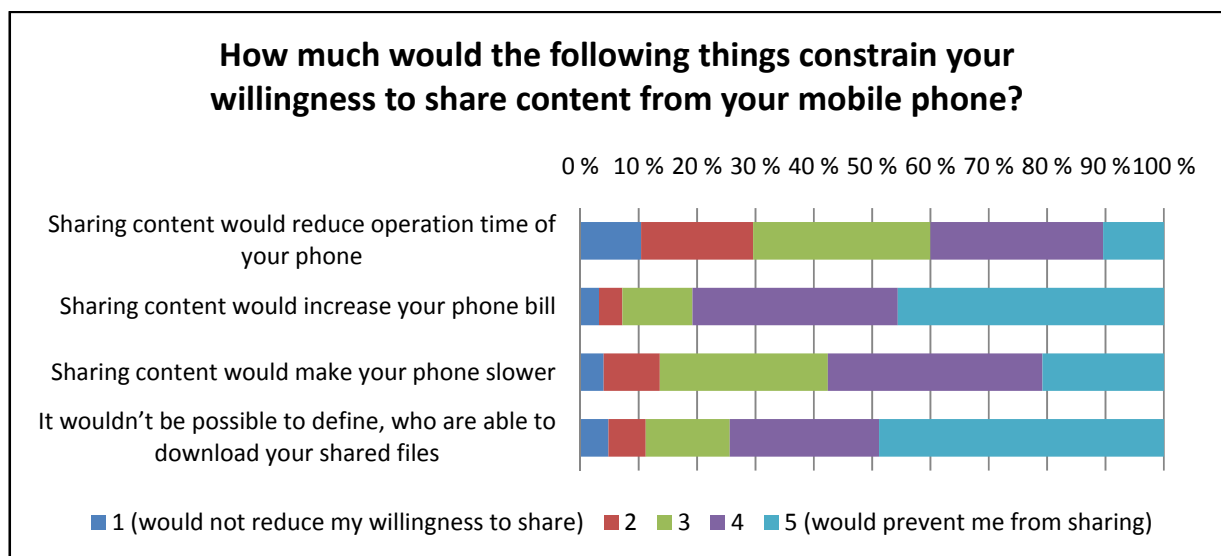


Figure 22: Constraints affecting willingness to download content with mobile phone

Results show clearly that people are not willing to pay extra for content downloading or sharing. Especially readiness to pay for sharing content is very low and most users would not share their files, if it would increase their phone bill. The possibility to define, who are able to download one’s shared files is extremely important. Almost 50 % of the

respondents claim that they are not willing to share files if this feature is not included in the application. This is understandable since most of the content in one’s mobile phone is personal. On the contrary operation time or performance reductions are not seen as major stoppers.

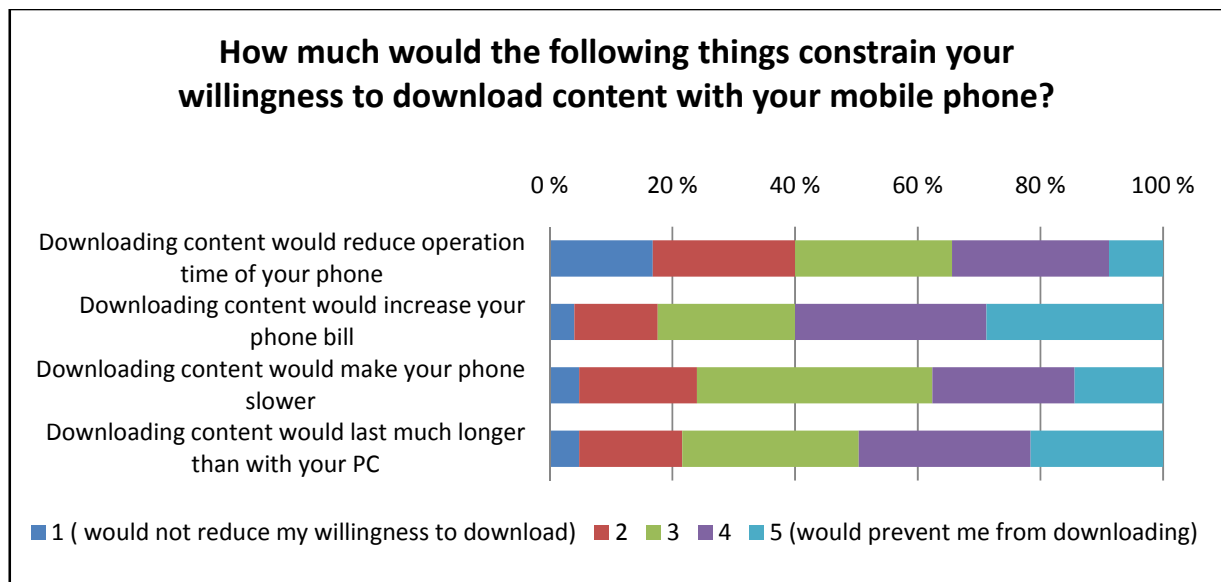


Figure 23: Constraints affecting willingness to share content from mobile phone

Possible constraints and other thoughts about downloading and sharing content to/from mobile phone were asked in an open question too. Usability issues were raised in many comments. Cumbersome user interface, too small screen size, restricted ability to handle large amounts of data, relatively small transfer rates and short battery life are some aspects which may have negative effect on usability. Mobile content sharing was also challenged with a question, why should content be shared with mobile phones when it can be done more comfortably with computers. Privacy concerns related mostly to content sharing. Due to the very personal nature of mobile phones, privacy and security issues were seen even more critical than in PC world. The monster of the Big Brother society made some respondents think, how anonymity is able to be provided while location information is used. Price-quality ratio of today’s data transfer deals was considered quite poor in some comments.

5 Discussion

The basic prerequisites for introducing mobile peer-to-peer services in the markets exist. At least respondents, presumably early adopters, surveyed in this study have a developed device base and fast enough data transfer connections. In addition, they use their mobile phones in various tasks, including content creation like taking pictures and recording video clips. The situation is getting better and better in time, since mobile phones continue their rapid development and HSPA solves problem with asymmetry in download and upload speeds.

The results suggest that support for group formation is a very important feature and this should be kept in mind when mobile P2P applications are developed. Self-created content is often very personal and, thus, there is an interest to share content only with the closest friends and family members. On the whole, respondents showed very little willingness to content sharing with unknown people. However, common interests increase the willingness to share and download content. The group sizes reported by the respondents vary from 4-person families to groups like car enthusiasts, which contain over million members. Thus group formation must be both granular and flexible. Privacy concerns were also brought out in the open questions. This has also much to do with the personal nature of mobile devices. A privacy mechanism allowing accountability is needed when people let others browse and download files directly from their mobile phones. Location information was considered especially sensitive, and a scenario of some Big Brother following every move of a user was seen as very scary.

The study reveals clearly that the use of mobile peer-to-peer services must not create extra expenses for users. This applies especially to sharing content. Hence flat-rate pricing for data transmission seems to be the only viable option. On the other hand, the HIIT study (Hietanen, Huttunen and Kokkinen 2008) interestingly claims that people would be ready to pay a monthly fee for the right to download unlimited amount of commercial content with their mobile phones. Nokia's Comes with Music business model (Nokia) tries to answer to that result. Operators have stronger control over users than fixed line ISPs have and P2P has a somehow bad reputation of consuming more traffic than ISPs would be

wanting. This means that developing profitable business models is as important as technical research.

Ease of use seems to be one of the critical issues, which excite use of mobile services. iPhone users, for example, spend more time and make more page impressions in HS.fi/mobiili (Stenbäck 2008), which may be caused by innovative touch user interface allowing use of intuitive gestures. The limitations of mobile phones must be taken into account and usability needs to be taken into consideration even more than in developing services for PCs. Adding functionality to mobile phones through installing applications is quite cumbersome and may scare many potential users away. To allow successful introduction of mobile P2P services, needed applications should be pre-installed to terminal devices. Creating incentives for sharing content to avoid free riding is another issue, which needs to be tackled.

The early adopters of mobile P2P content sharing services would probably be those who have been used to use mobile phones in various tasks and have used P2P file sharing services with their PCs. Depending on the implementation of the services and phone model requirements, also those who have not used P2P earlier, would be possible users. After all, users are not interested in the technological realization of services, if the service fulfills a need. The most promising mobile peer-to-peer services relate to photo and video sharing. Location information may add value to mentioned photo sharing service, but not only to that one. However, mobile P2P does not need to answer to all content sharing use cases. In some cases conventional E-mail, photo gallery in the web or some other solutions may suit better. But if successfully implemented, mobile peer-to-peer content sharing services may take lion's share in personal content sharing.

6 Conclusions and future research

In this study, mobile phone users' attitudes towards mobile P2P content sharing were analyzed. Analysis covered interest in both downloading and sharing different content types. Based on the results of the survey conducted among 125 mobile phone users it can be seen that there is a clear interest in mobile P2P content sharing services, especially if flexible group formation is enabled. Mobile phone users namely want to share their content only with certain people, who are either well-known or share similar interests. There is a strong free riding attitude, particularly when sharing content with unknown people is considered.

Experience in content sharing increases the interest in mobile content sharing. Engineering studies were the other factor that affected positively on interest. However, the survey also suggests that new possibilities of mobile P2P, like using location information to share for example POIs or maps, may attract totally new user groups, if the usability of the services is taken properly into account in planning them. Interestingly negative effects on mobile phone performance would not limit the usage of mobile P2P services as much as additional monetary costs and missing possibility to define, who are allowed to download personal content.

This study concentrated on a quite homogeneous group of people, namely engineering students in their twenties. Thus a study among broader audience would be interesting. Interview-based study of some more concrete mobile P2P service prototypes could reveal applicability of them. Mobile P2P can also offer interesting business cases for mobile operators and other stakeholders, especially when commercial content is considered. Thus, analysing business implications of these results may reveal business possibilities. To inhibit free riding to reduce the value of mobile P2P, possibilities to insert incentives for sharing content should be researched as well.

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Appendices

Appendix A – Web questionnaire

Survey on file sharing

The aim of this survey is to examine interests in mobile file sharing. The results of the survey will be used to guide research to better match user expectations.

1. File sharing using fixed Internet connection

0002: Have you ever shared your own photos on the Internet?

Please choose *only one* of the following:

- Yes
 - No
-

[Only answer this question if you answered 'Yes' to question '0002 ']

0003: Which photo sharing applications have you used?

Please choose *all* that apply:

- Flickr
 - Picasa
 - MySpace
 - Facebook
 - Irq-galleria
 - Kuvaboxi
 - Your own blog
 - Your own webpage
 - FTP
 - Other, which? _____
-

[Only answer this question if you answered 'Yes' to question '0002 ']

0004: Have you restricted the access to your photos so that only some people can see them?

Please choose *only one* of the following:

- Yes
 - No
 - I don't know
-

0005: Have you ever shared your own video clips on the Internet? (e.g. in YouTube)

Please choose *only one* of the following:

- Yes
 - No
-

0006: Have you ever written a blog post?

Please choose *only one* of the following:

- Yes
 - No
-

0007: How often do you participate in discussions on web forums?

Please choose *only one* of the following:

- Daily
 - Weekly
 - Monthly
 - Couple of times a year
 - Less frequently than couple of times a year
 - No, I don't participate in discussions on web forums
-

2. P2P file sharing

This section has questions concerning your peer-to-peer content sharing. Most of the questions consider your current usage of peer-to-peer applications.

0008: Do you understand the concept of peer-to-peer file sharing?

Please choose *only one* of the following:

- Yes, I know the basics
 - Yes, I even have some technical understanding
 - No, I don't understand it
-

0009: Have you ever downloaded any content or files using a peer-to-peer application?

Please choose *only one* of the following:

- Yes
 - No
 - I don't know
-

0010: Have you ever shared any content or files using a peer-to-peer application?

Please choose only one of the following:

- Yes
 - No
 - I don't know
-

[Only answer this question if you have NOT answered 'No' to question '0010 ']

0011: Have you ever been the first sharer of content or files using a peer-to-peer application?

Being the first sharer means that you set some content available to other peer-to-peer application users so that you haven't downloaded that content through the same p2p network.

Please choose *only one* of the following:

- Yes
 - No
 - I don't know
-

[Only answer this question if you have NOT answered 'No' to question '0009 ' *and* if you have NOT answered 'No' to question '0010 ']

0012: Which of the following peer-to-peer applications have you used? You may select several answers.

Please choose *all* that apply:

- Napster
 - Gnutella (e.g. Limewire, Morpheus)
 - Kazaa
 - Freenet
 - eDonkey or eMule
 - Bittorrent (e.g. Bittorrent, Azureus, uTorrent)
 - Direct Connect (DC++)
 - P2PTV (e.g. Joost, Sopcast, TVUPlayer, Coolstreaming, TVants)
 - SymTorrent or Symella
 - Other, which? _____
-

[Only answer this question if you have NOT answered 'No' to question '0009 ' *and* if you have NOT answered 'No' to question '0010 ']

0013: How often do you use peer-to-peer applications on average?

Please choose *only one* of the following:

- Daily
 - Weekly
 - Monthly
 - Couple of times a year
 - Less frequently than couple of times a year
-

3. Mobile phone usage

0017: What kind of mobile phone do you have?

Please choose *only one* of the following:

- A GSM phone
 - A 3G phone
 - I don't know if it is a GSM or 3G phone
 - I don't have a mobile phone?
-

[Only answer this question if you have NOT answered 'I don't have a mobile phone?' to question '0017 ']

0018: Which of these functions have you used with mobile phone?

Please choose *all* that apply:

- Taken a picture
 - Listened to music
 - Read emails
 - Used a calendar
 - Browsed web pages
 - Used instant messaging (MSN Messenger or equivalent)
 - Called someone with VoIP software like Skype
 - Downloaded a ring tone
 - Downloaded a mobile game
 - Downloaded some other mobile content (video, pictures)
-

[Only answer this question if you have NOT answered 'I don't have a mobile phone?' to question '0017 ']

0019: Do you have flat-rate pricing for data transfer in your mobile phone subscription?

Flat-rate pricing means that you pay a fixed sum for a certain time (e.g. a month) and you are able to transfer as much data as you will. Fixed internet subscriptions through ADSL and Cable are good examples of flat-rate pricing.

Please choose **only one** of the following:

- Yes
- No

[Only answer this question if you have NOT answered 'I don't have a mobile phone?' to question '0017 ']

0020: How much of the following types of content have you created on mobile phone?

Please choose the appropriate response for each item:

	Many (over 20)	Some (1-20)	None, but I'm interested	None and I'm not interested
Photos	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Video clips	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Writings (e.g. news, blog posts, discussion forum posts)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Calendar notes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4. Possible Interests – Downloading

Downloading is an action, where you view or download files that other users have shared.

0021: How interested would you be in downloading the following types of content created by other users with your mobile phone?

Please choose the appropriate response for each item:

	Very interested	Quite interested	Not very interested	Not interested at all
Photos	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Video clips	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Writings (e.g. news, short books, blog posts)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Calendar notes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Link recommendations to web pages	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Maps and POIs (POI = Point Of Interest: Position-related map information, e.g. gas stations or pizzerias in a particular area)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

0022: How interested would you be in downloading content from the following groups of people with your mobile phone?

Please choose the appropriate response for each item:

	Very interested	Quite interested	Not very interested	Not interested at all
Family and friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Friends' friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Unknown people	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Study/work colleagues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Some interest group (hobbies, interests, clubs - e.g. your football team, Madonna fan club.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

0023: How interested would you be in downloading the following types of professionally created content from commercial content providers with your mobile phone?

Please choose the appropriate response for each item:

	Very interested	Quite interested	Not very interested	Not interested at all
Pictures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Video clips (e.g. news, TV series, movies)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Writings (e.g. news, articles, short stories, blog posts)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Music (e.g. MP3 files)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Applications (e.g. mobile games)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Maps and POIs (POI = Point Of Interest: Position-related map information, e.g. gas stations or pizzerias in a particular area)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Possible Interests - Sharing

Sharing is an action where you let other users to view and download your shared files.

0024: How interested would you be in sharing the following types of content from your mobile phone?

Please choose the appropriate response for each item:

	Very interested	Quite interested	Not very interested	Not interested at all
Your photos	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your video clips	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your writings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your calendar notes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Links to interesting web pages	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your music / audio clips	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your applications (e.g. mobile games)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Your maps and POIs (POI = Point Of Interest: Position-related map information, e.g. gas stations or pizzerias in a particular area)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

0025: How interested would you be in sharing aforementioned content to following groups of people from your mobile phone?

Please choose the appropriate response for each item:

	Very interested	Quite interested	Not very interested	Not interested at all
Family and friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Friends' friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Unknown people	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Study/work colleagues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Some interest group (hobbies, interests, clubs - e.g. your football team, Madonna fan club.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. Constraints affecting mobile sharing

0026: Thoughts, comments or doubts concerning downloading or sharing content from/to mobile phone?

Please write your answer here:

0027: How much would the following things constrain your willingness to share content from your mobile phone? (1 = would not reduce my willingness to share, 5 = would prevent me from sharing)

Please choose the appropriate response for each item:

- | | | | | | | | | | | |
|---|--------------------------|---|--------------------------|---|--------------------------|---|--------------------------|---|--------------------------|---|
| Sharing content would reduce operation time of your phone | <input type="checkbox"/> | 1 | <input type="checkbox"/> | 2 | <input type="checkbox"/> | 3 | <input type="checkbox"/> | 4 | <input type="checkbox"/> | 5 |
| Sharing content would increase your phone bill | <input type="checkbox"/> | 1 | <input type="checkbox"/> | 2 | <input type="checkbox"/> | 3 | <input type="checkbox"/> | 4 | <input type="checkbox"/> | 5 |
| Sharing content would make your phone slower | <input type="checkbox"/> | 1 | <input type="checkbox"/> | 2 | <input type="checkbox"/> | 3 | <input type="checkbox"/> | 4 | <input type="checkbox"/> | 5 |
| It wouldn't be possible to define, who are able to download your shared files | <input type="checkbox"/> | 1 | <input type="checkbox"/> | 2 | <input type="checkbox"/> | 3 | <input type="checkbox"/> | 4 | <input type="checkbox"/> | 5 |

0028: How much would the following things constrain your willingness to download content with your mobile phone? (1 = would not reduce my willingness to download, 5 = would prevent me from downloading)

Please choose the appropriate response for each item:

- | | | | | | | | | | | |
|---|--------------------------|---|--------------------------|---|--------------------------|---|--------------------------|---|--------------------------|---|
| Downloading content would reduce operation time of your phone | <input type="checkbox"/> | 1 | <input type="checkbox"/> | 2 | <input type="checkbox"/> | 3 | <input type="checkbox"/> | 4 | <input type="checkbox"/> | 5 |
| Downloading content would increase your phone bill | <input type="checkbox"/> | 1 | <input type="checkbox"/> | 2 | <input type="checkbox"/> | 3 | <input type="checkbox"/> | 4 | <input type="checkbox"/> | 5 |
| Downloading content would make your phone slower | <input type="checkbox"/> | 1 | <input type="checkbox"/> | 2 | <input type="checkbox"/> | 3 | <input type="checkbox"/> | 4 | <input type="checkbox"/> | 5 |
| Downloading content would last much longer than with your personal computer | <input type="checkbox"/> | 1 | <input type="checkbox"/> | 2 | <input type="checkbox"/> | 3 | <input type="checkbox"/> | 4 | <input type="checkbox"/> | 5 |
-

7. Social Networks

0029: How many people do you estimate belonging to the following groups?

Family: _____

Friends: _____

Study/work colleagues: _____

Contacts in the phone book of your mobile phone: _____

0030: Suppose that groups (e.g. for hobbies, activities, interests, clubs) could be created for sharing content. In how many groups would you actively participate with your mobile phone?

Please write your answer here:

0031: What would be the theme of the most important group? (E.g. punk music, your football team, french cuisine, modern art)

Please write your answer here:

0032: What is the number of people belonging to this group?

Please write your answer here:

8. Background questions

These questions are for examining statistically the relationship between the background information and the opinions. The answers in this section will not be used to identify your answers individually.

0033: Your age? (in years)

Please write your answer here:

0034: Your gender?

Please choose *only one* of the following:

- Female
 - Male
-

0035: Are you a student?

Please choose *only one* of the following:

- Yes
 - No
-

[Only answer this question if you answered 'Yes' to question '0035 ']

0036: Your educational institute?

Please choose *all* that apply:

- HUT - Helsinki University of Technology
 - Other, which? _____
-

[Only answer this question if you answered 'HUT - Helsinki University of Technology' to question '0036 ']

0037: Your study programme?

Please choose *only one* of the following:

- TLT
 - AUT
 - BIO
 - ENE
 - EST
 - GMA
 - INF
 - KEM
 - KON
 - KTA
 - MAR
 - MTE
 - RAK
 - TFY
 - TIK
 - TUO
 - YHD
 - MACADAMIA
 - MBI
 - MOBILE
 - NORDSECMOB
 - Other, which? _____
-

0038: Are you currently employed?

Please choose *only one* of the following:

- Yes, full-time
 - Yes, part-time
 - No
-

0039: Nationality?

Please choose *only one* of the following:

- Finnish
 - Other, which? _____
-

9. Student number

The student number is **only** used for the exam credit. If you are not part of the Signaling protocol course, you can leave it blank.

0040: Your student number if you are attending the Signaling Protocols course?

Please write your answer here:

<p style="text-align: center;">Submit Your Survey. Thank you for completing this survey.</p>
