# USAGE PATTERNS OF MOBILE SUBSCRIBERS: REGULATORY OBSERVATIONS IN FINLAND

HEIKKI HÄMMÄINEN, ANTERO KIVI, HANNU VERKASALO

Helsinki University of Technology
Networking Laboratory
P.O. Box 3000 FIN-02015, FINLAND
{heikki.hammainen, hannu.verkasalo, antero.kivi}@tkk.fi

## ABSTRACT

Regulators need accurate data on service usage in addition to general information on markets and technology. This study presents a new type of tool, handset-based monitoring, for collecting and analyzing detailed data on usage patterns of mobile subscribers. Results of a panel organized in Finland are described and mapped to the relevant regulatory issues. Observations indicate that Finnish subscribers are currently using downloadable applications, web portals, and unlicensed spectrum without unnecessary market obstacles. In addition, benefits of new technology, especially WCDMA, gain some evidence, which suggests that the regulatory push of certain new technologies can be successful. Peer-to-peer applications and copyrighted content also seem to enter the mobile space thus raising the issue of copyright infringement. These initial observations suggest that handset-based monitoring can be a relevant tool also for regulators.

KEYWORDS: regulation, mobile, usage, measurement, handset-based monitoring.

## INTRODUCTION

Recently the new open programmable platforms for mobile handsets have enabled an accurate handset-based monitoring of subscriber behavior. Mobile operators, content providers, handset suppliers, and regulators can exploit handset-based monitoring data for several purposes, but often the motivation is to better understand the subscriber preferences and their fulfillment. This paper reports results achieved in projects LEAD[1] and COIN[2].

The authors have not found prior art on exploitation of automated handset-based monitoring for consumer research. Similar handset-based monitoring, however, has been used for studying social interactions of a closed user community [1]. Lots of related traditional research on mobile subscriber behavior exist based on other methods such as direct user observation (e.g. [2] and [3]), consumer questionnaires (e.g. [4]), network-based traffic statistics (e.g. [5]), and economic modeling (e.g. [6] and [7]).

The present paper takes the regulator's viewpoint and focuses on identifying the parts of collected data that can give insight to the currently relevant regulatory topics. First the regulatory questions are identified and mapped to the Finnish regulatory environment. After explaining the research

[1] Optimal Rules for a Leading Mobile Data Market (LEAD) was a national research project funded by Finnish Funding Agency for Technology and Innovation, Finnish Communications Regulatory Authority, and the industrial partners Nokia, TeliaSonera Finland, Elisa, and DNA Finland (see www.netlab.tkk.fi/tutkimus/lead).

[2] Dynamics of Competition and Innovation in the Converging Internet and Mobile Networks (COIN) is a national research project funded by Finnish Funding Agency for Technology and Innovation, Ministry of Transport and Communications, and the industrial partners Nokia, Digita, TeliaSonera Finland, Elisa, and DNA Finland (see www.netlab.tkk.fi/tutkimus/coin).

method, the empirical observations are elaborated and discussed. Finally the conclusions are presented to support the suggested usefulness of handset-based monitoring for regulators.

## REGULATORY QUESTIONS

Which regulatory issues can be tackled with handset-based monitoring and usage statistics? Intven et al [8] present widely accepted objectives of telecommunications regulation in their handbook. Comparing these objectives with the data set accessible using handset-based monitoring, two high-level objectives, 1) foster competitive markets, and 2) optimize the use of scarce resources, can be identified as starting points for a more detailed analysis. The following regulatory questions come up from this analysis:

- Is the web sites market competitive? Competition is likely to exist if mobile subscribers can choose between independent web sites and if the web traffic is scattered among sites.

- Is the 3rd party applications market competitive? Competition is likely to exist if mobile subscribers can choose between 3rd party applications and if their application usage profiles are scattered. The importance of applications managed by mobile operators versus those managed by operator-independent actors is evaluated based on usage statistics. This helps the regulator to understand the current power positions of different application segments and actors.

- What is the usage of the license-exempt spectrum, especially 2.4GHz? Since the licensed wide-area spectrum is generally easier to monitor than the unlicensed local-area spectrum, a need exists for getting accurate usage data of the unlicensed 2.4GHz, and more specifically of the Bluetooth and WLAN traffic. Since Bluetooth is more commonly used today, it can be assessed using handset-based monitoring, while WLAN remains for future study.

- When are the peer-to-peer applications and commercial content likely to create copyright infringement issues in the mobile Internet? This question can be discussed based on the current usage statistics of applications and content types.

- Which technologies could the regulator successfully favor? Regulators have tools, e.g. conditional handset subsidies, to favor the adoption of certain technologies. One question is the impact of different radio interfaces (GSM, WCDMA) on subscriber behavior. This impact is relevant in Finland because the regulator has already decided to promote WCDMA. Handset-based monitoring can be used to assess the effect of this decision.

The value of these questions can be assessed by mapping them to the Finnish regulatory process described in Figure 1. The Finnish process is subordinate to the European Union level regulatory processes but has some national flavors. Ministry of Transport and Communications (MINTC) is responsible for drafting the new laws for the telecommunications sector, while Finnish Communications Regulatory Authority (FICORA) takes care of the corresponding legal monitoring. In some cases the responsibilities between sector-specific and general competition issues covered by Finnish Competition Authority (FCA) are not clear and require consultations.

MINTC and FICORA together run special interests groups consisting of experts from the market parties in order to efficiently build understanding of the future regulatory issues. MINTC and FICORA also have budgets for using independent consultants to produce focused reports on

relevant issues. In principle, handset-based monitoring could be included in the regulator's toolbox both in the legal drafting and legal monitoring phases. Ideally the regulator should implement handset-based monitoring studies without the help of market parties, but this is challenging as will be seen later on.

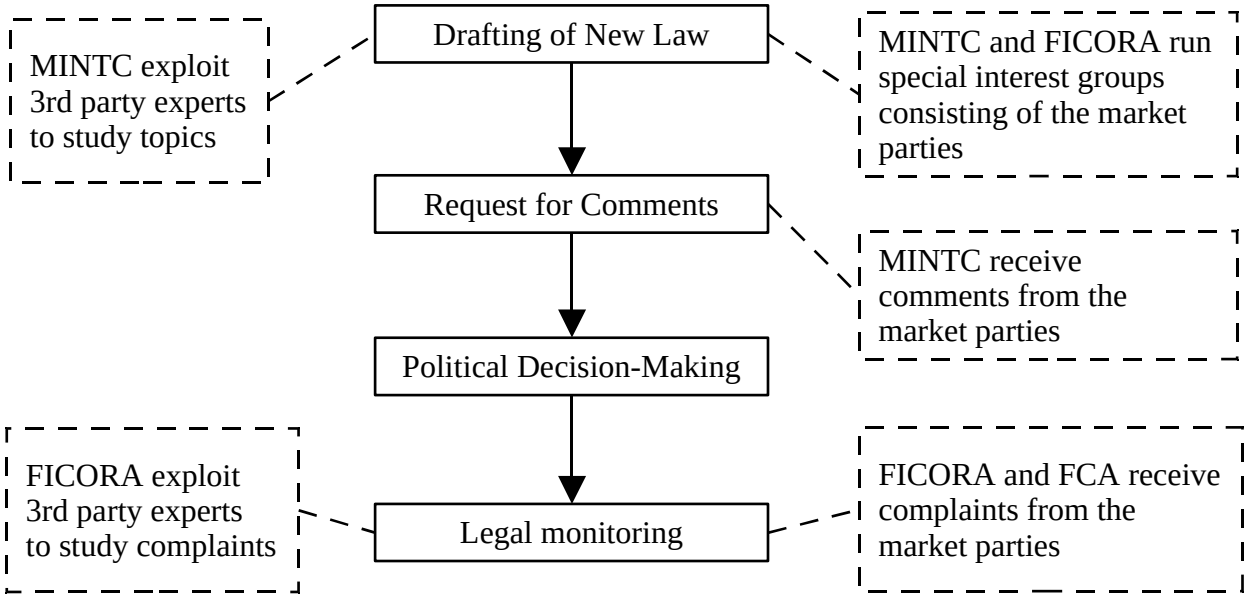


**Figure 1. Telecommunications regulatory process in Finland**

## RESEARCH METHOD

Figure 2 illustrates the implementation of the data acquisition process. The information system itself is open towards the public Internet, subscriber registration being implemented as a normal protected web service. New subscribers are recruited by advertising in handset shipment boxes, sending text messages, or promoting in the Internet. All subscribers must approve the contract provided by the panel organizer, making sure that everybody is aware of the data retrieval. The three upper modules of the information system deal with the problem of registering the subscriber and downloading the monitoring software over a GPRS link to the subscriber's device. The subscriber will always be asked to confirm the download process of the monitoring software by his handset.

At first, subscribers interact with the web-based information system, after which they receive an acknowledgement, which basically makes sure that the software itself can be downloaded and the subscriber has read the contract. In the upper three modules subscribers are provided with a subscriber identification number. In all the lower modules, subscribers and data are only mapped together with these subscriber identification numbers. Thus, the idea is to support anonymity and protect subscribers' privacy in the studies. At the lowest level of the system architecture handsets archive and send the data on usage factors through a GPRS link either on a daily or weekly basis, depending on the usage factors involved and type of data. The information system facilitates some automatic reporting during panel projects, but handmade data analysis and statistical tests are typically used in the final post-panel study phase. For a review of the full process, see [9] and [5].

One should take into account the issues of privacy and security constantly discussed in the case of intelligent handset-based software clients [10]. The utilization of such software asks not only for technological understanding, but also legal, business and marketing capabilities.

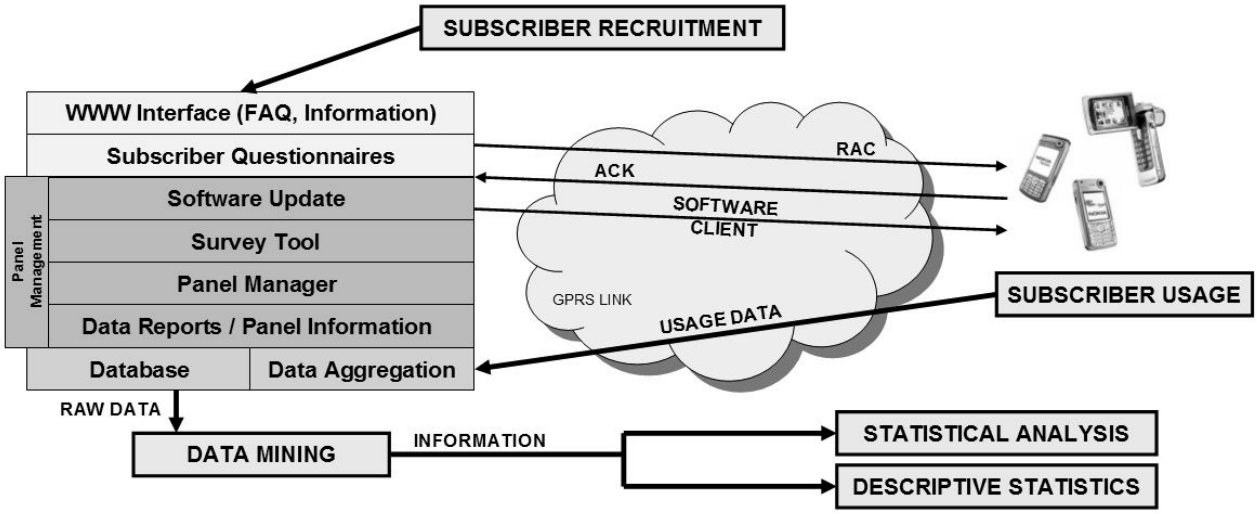


**Figure 2. The process of capturing and archiving subscriber data**

The monitoring software overcomes many problems of pure questionnaire-based surveys. Most importantly, this type of measured data is objective. That is, sometimes subscribers' own perceptions of usage are not in line with actual usage. Because the monitoring software acquires data from the handset, the subscriber cannot affect the results through his own interpretations. Secondly, the monitoring software acquires information on all relevant smartphone functions, and with very high accuracy. The subscriber himself, or network-based monitoring platforms, could not provide e.g. information on the absolute data transmission amounts contingent on the used application (e.g. messaging, gaming or browsing). Among others, this problem has been identified by Minges [10].

## EMPIRICAL OBSERVATIONS

Using the described general research method, a consumer panel was organized in Finland with a set of 540 GSM/WCDMA subscribers using Nokia Symbian S60 handsets. By requiring at least three weeks of active usage, the user base narrowed down to 482 subscribers. The panel took place in autumn 2005 during a period of two months. In cooperation with all three licensed mobile operators (TeliaSonera, Elisa, DNA Finland) the panelists were found by sending GSM text messages to a selection of S60 users. Panelists were given a small monetary compensation of 20 euros for their efforts and for the traffic costs of automatic uploading of the collected data.

The resulting data was analyzed using the SPSS statistical package [11]. Data includes detailed time-stamped events per subscriber such as voice calls (in/out traffic volumes, duration, distribution of contacts), messaging (in/out traffic volumes, distribution of contacts, per SMS/MMS), packet traffic (in/out traffic volumes, per GSM/EDGE/WCDMA, Bluetooth), applications (names, downloads, session launches, session durations, in/out traffic volumes), web sites (visits per site), and so on. In addition to detailed usage data, demographic data was collected from the subscribers via web-based questionnaires (age, sex, occupation, subscription type, usage experience, bill size,

etc). Demographic and detailed usage data together enable an extremely accurate analysis of subscriber behavior when using a systematic process and rigorous statistical methods as explained in full detail by Verkasalo [9].

Unlicensed radio bands - Bluetooth

Bluetooth, a short range radio technology on an unlicensed band, can substitute some use of cellular networks and licensed radio spectrum. Indeed, Bluetooth usage is well represented in the collected dataset. Bluetooth results are presented in Appendix A. In machine-to-machine communication (e.g. synchronizing calendar with laptop or using Bluetooth headsets) Bluetooth usage was identified with 17% of the panelists. The most popular use cases seem to be the Bluetooth connectivity/access to either desktop or laptop computers. The second most popular use case is the access to other handsets. By pairing and accessing other handsets the subscriber can look for certain files or content.

The way to transfer content between subscribers within close proximity is through Bluetooth messaging. In Bluetooth messaging the subscriber effectively sends a file from a computer or handset to another device. The user of the recipient device is then asked whether he is willing to either accept or decline the file transfer. Based on measurements, 29% of panelists have received Bluetooth messages, while 34% have sent Bluetooth messages. A typical Bluetooth messaging user sent 0.4 Bluetooth messages per week and received 0.3 Bluetooth messages per week. Therefore a typical panelist uses Bluetooth messaging only occasionally, though some people use it very actively (there were 6 panelists who sent an average of more than 7 Bluetooth messages per week).

Information on all Bluetooth attachments sent or received during the panel was collected. Bluetooth attachments include the actual content of the Bluetooth message. 789 inbound and 1896 outbound Bluetooth attachments were identified in the panel. This is in line with the observation that more subscribers sent Bluetooth messages than received ones. It also seems that subscribers seem to send Bluetooth messages more actively than receive them (which is of course usually out of their control). Appendix A reveals the detailed distribution of Bluetooth attachments. Most outbound Bluetooth attachments are photos or images, most likely photos generated by the panelists. In inbound Bluetooth attachments there is a lot more variety. In fact applications, photos and music all represent about a quarter of the attachments. It should be noted that MP3 music files represent 16.2% of inbound Bluetooth attachments and 5.4% of outbound attachments.

Comparisons to MMS and email attachments reveal that Bluetooth attachments are mostly related to consumer-generated content, such as photos, and some entertainment content (particularly in inbound messages) including music, video and photos. In MMS messages almost all attachments are photos, and in email attachments a more heterogeneous distribution of content is evident (including e.g. office documents, games, applications etc.).

The measurements verify that subscribers indeed value Bluetooth as a complement and substitute to cellular network. Operators might have incentives to disable Bluetooth connectivity because of its substitution potential. In the US this has generated at least one law suit[3] due to restriction of consumer choice when an operator has disabled Bluetooth connectivity. From the regulatory point of view innovation and consumer choice clearly should be fostered [8]. Regulators, consumer activists, and handset vendors state that limiting unlicensed band connectivity, Bluetooth or WLAN, generally works against innovation and reduces social surplus [12]. However, operators have not set any such restrictions in Finland so far.

[3] *Opperman, et al. v. Cellco Partnership d/b/a Verizon Wireless*, Case No. BC 326764, Superior Court of the State of California for the County of Los Angeles, 2005.

3rd party applications

Symbian smartphones support both Java and native C++ Symbian applications. The developed applications can be installed on the smartphones by subscribers themselves, which has created a market of 3rd party applications. 3rd party applications basically refer to applications developed by external actors, not by the smartphone vendor. Built-in applications are standard Symbian smartphone applications factory-installed on top of the operating system platform.

3rd party applications hold an important role, as they provide the subscriber a possibility to customize the handset and service. From the handset vendor point of view open platforms increase the direct network effects which further drive the demand and introduction of value-added services. The regulator should be interested in consumer choice and freedom. Based on the results the existence of 3rd party application markets is becoming important, since 8% of all application launches are 3rd party applications. Excluding the usual built-in communication applications, such as the built-in messenger, phonebook and logs applications, this share increases to 30%.

Note that in some cases people have installed applications before the panel started, and in those cases the installations were not identified, only the launches during the course of usage. Sometimes operators and handset vendors have also included some preinstalled 3rd party applications in the handset. Being unable to identify how the 3rd party application ended up in the handset, nevertheless it was identified that 435 (88%) subscribers had at least once used other than a built-in application.

The 3rd party application ranking is presented in Appendix B. Many applications experience intensive usage. 3rd party Internet browsers, messaging clients, navigation applications, virus scanners, office applications and multimedia players show that the existence of 3rd party application market is valued by smartphone customers. Actually many 3rd party applications receive a lot of attention from their users. Median usage frequencies (average share of active usage days when the application was really used) exceeding 10% or usage intensities (non-accidental launches per day) approaching 0.5 launches per day are already comparable with many of the built-in applications. All in all, 217 subscribers (44%) have installed at least one application during the panel. Those who installed applications installed an average of 0.3 applications per week, and typically 2 different applications during the panel. In total the whole panel installed 1709 applications. Cumulatively 536 different installed applications were identified. By comparing the distribution of application installations (3rd party applications) and launches (mostly built-in applications), which are both presented in Appendix B, it can be seen that 3rd party applications largely consist of utility applications and games, whereas built-in application usage is dominated by PIM (personal information management) and messaging applications.

The panel indicates that subscribers value the capability of installing 3rd party applications. No restrictions on installation were identified during the panel. However, the support and monitoring of 3rd party application markets might be a relevant regulatory concern based on the observations.

3rd party content

44% of panelists had generated data with some 3rd party applications, and cumulatively over the entire panel 3rd party applications generated 26% of all traffic. Examples of these applications are messaging clients (e.g. Profimail and AgileMessenger), 3rd party browsers (e.g. Opera and NetFront) and P2P (peer-to-peer) applications (e.g. Symella). Some of these applications facilitate transfer of 3rd party content. For instance, 26 panelists were identified as users of AgileMessenger that provides an alternative to SMS and MMS in messaging. Another application, Symella resembles the P2P applications of the fixed Internet. Only one Symella user was identified in this

panel, but in another similar research Symella was already identified as one of the most intensively used data applications [12].

The effect of 3rd party data applications and type of content transmitted are relevant topics from the regulatory point of view. Together with unlicensed radio bands P2P applications will provide alternatives to many vertically bundled services currently provided by cellular operators. These alternatives also increase the probability of content copyright infringements as already seen in the P2P space of the fixed Internet, e.g. law suits against Napster[4] and operators and their customers[5]. However, no copyright infringements by mobile subscribers have been publicly discovered in Finland, so far.

Packet data usage

The data set included both panelists using GSM/EDGE, and panelists using WCDMA capable handsets (with GSM/EDGE capability as well). Thus, the effect of handset radio capability on packet data usage could be studied.

Some modem usage, i.e. people using their handsets as modems for a laptop or PC was observed. The share of such modem usage was about 25% of total packet data traffic volume for all panelists, whereas the corresponding shares were 9% and 40% for GSM/EDGE and WCDMA capable handset users, respectively. Thus, it seems that WCDMA usage increases modem usage significantly, although the high shares of modem usage do partly result from the high volume usage of a few heavily data using panelists.

By excluding the modem traffic from analyses, the solely handset-originated data traffic can be studied. Counting average usage figures on a sample including some very high volume users poses some challenges. Using medians instead of (arithmetic) means sometimes provides more describing results in these cases. A graph illustrating average (mean and median) packet data traffic volumes per panelist for GSM/EDGE and WCDMA capable handset users is presented in Appendix C, Figure 1. The average data usage volumes were clearly higher for WCDMA capable handset users, regardless of which average was used. Similar results were found when including the panelists' packet data traffic tariff plans into the analysis, i.e. usage was higher with more capable handsets also within alternative tariff categories.

The collected usage data also enables studying the application usage profile for different panelists. The breakdown of packet data traffic volume between browsing (web/wap browsers), messaging (MMS, email, instant messaging), and other applications for both GSM/EDGE and WCDMA capable handsets is presented in Appendix C, Figure 2. Comparing the two profiles, the share of browsing is much higher for WCDMA handset users, at the expense of messaging applications. Indeed it seems that the relative share of browsing increases with data usage volume. The traffic volume of other applications increases as well, but this growth is overshadowed by the relatively higher increase in browsing. The volume of traffic related to messaging application remains almost the same, implying that messaging usage is less dependent on handset capability.

The obtained results imply that the use of new and more capable technology indeed seems to increase data usage, concerning both modem usage and truly mobile data usage. Thus, it seems that if the Finnish regulator's decision to allow the bundling of 3rd generation (WCDMA capable) handsets with the mobile subscription [12] will indeed speed up the renewal of Finnish mobile terminal base towards more advanced and capable handsets, it also has the potential to raise the

[4] 2001 US Dist. LEXIS 2186 (N.D. Cal. Mar. 5, 2001), aff'd, 284 F. 3d 1091 (9th Cir. 2002).
[5] Recording Industry Association of America v. Verizon Internet Services, 2003 U.S. Dist. LEXIS 681 (D.D.C. 2003).

Finnish mobile data usage to a new level. Also the regulator in South-Korea relies on the same logic when proactively pushing new radio technologies [13].

Web browsing

Panelist browsing patterns could also be studied with the collected data. Data was registered at the domain name level, with all browsing within the sub pages of a domain being counted as one web/wap site visit. The potentially increasing effect of pre-installed or embedded bookmarks on usage of the bookmarked sites can be studied with this data.

Embedded bookmarks can end up at the handset browser at least in three ways. First, the handset manufacturer can add bookmarks to the factory-installed browser(s) of the handset. Second, the mobile operator's connection settings automatically sent to new handsets observed in the mobile network also add the operator's bookmarks to the platform browser. Moreover, the operator might have some control over the browser bookmarks in markets where handset customization is used. Third, some bookmarks might come with pre-installed 3rd party browsers, and link to browser-specific sites.

At a general level, browsing was not very centralized, as 44% of all site visits went to top 10 domains. At the individual level, however, a panelist's browsing was rather centralized as the top 5 destinations corresponded to 69% of the panelist's all site visits. The share of site visits to mobile operator controlled domains was about 32% of all site visits. It is reasonable to assume that these site visits result dominantly from the use of the operator's embedded bookmarks. On the other hand, the share of the manufacturer's bookmark pointing to a software downloading site was less than 1% of total. The remaining 68% of all web/wap site visits went to other, non-bookmarked sites.

The positive effect of embedded bookmarks to browsing can be seen more clearly while regarding the share of panelists that had visited the bookmarked sites at least once during the panel. About 68% of the panelists had visited operator sites and 17% the manufacturer's software download site during the panel. Especially the share of the manufacturer bookmark is vastly higher than its share of all site visits, implying that embedded bookmarks are at least tested by the user. Thus, it is clearly an advantage for a service provider to have its site/portal as a pre-installed bookmark on the handset.

It seems that currently the handset manufacturer does not use the privileged position of embedding bookmarks to its platform browser to a large extent. However, the share of mobile operators' sites, while not being dominant over other sites, implies that operators' do have some influence over the subscribers' usage behavior. Thus, both the embedding of operator bookmarks and their usage should be monitored by the regulator in the future. This becomes even more important, as the operator's power over the handset and the subscriber increases with handset bundling.

## DISCUSSION

The empirical measurement results indicate that panelists exercise free choice in the Finnish mobile data market. On the other hand, no legal complaints were found related to the studied regulatory issues, which confirms the good competitive situation of the emerging mobile data market in Finland. It should be noted though that the panel study is limited to a sample of early adopters because the penetration of smartphones is still less than 10% and because the panelists needed to show an initial capability of downloading the monitoring client software. The average consumer behavior is likely to change as the mobile Internet becomes a mainstream service.

This paper covers certain regulatory issues suitable for analysis using handset-based monitoring. In the near future the same approach can be used to study several other topics. For instance, by adding some background variables in the questionnaires panelists can be distinguished according to type of subscription: handset bundling vs. no handset bundling. Handset bundling is relevant because the law has changed in Finland after our panel study and allows now subscription contracts with handset bundling. Performing this same analysis on annual basis facilitates a better understanding of the consequences of handset bundling, among other things.

Another future topic is the WLAN capability in handsets which raises questions such as usage profiles in public compared to private WLAN hotspots and usage profiles of operator services compared to 3rd party services over WLAN. One specific example is voice over IP over WLAN which may appear as a mobile operator service, e.g. Generic Access Network [14], or as an Internet service, e.g. Skype [15]. Note that handset-based monitoring allows collecting data on usage that happens only inside the handset (local applications), between people and devices locally (local area applications), and internationally (Internet applications). Collecting similar data per consumer through other processes would be difficult, or even impossible.

The possibility of regulators to exploit handset-based monitoring is not straight-forward. One limitation is that regulators cannot easily implement independent panels without the help of market actors. Another limitation is that the voluntary consumers assume strict anonymity which precludes any direct measures against individual panelists, e.g. regarding copyright infringements, as well as the exploitation of panelists to testify against other market actors.

## CONCLUSIONS

These empirical results indicate that Finnish mobile subscribers are currently using downloadable applications, web portals, and unlicensed spectrum without unnecessary market obstacles. Regulators generally assume that complaints will emerge in case of illegal behavior, which certainly is a proven approach in the legal tradition. However, regulators can use the accurate usage statistics achieved through handset-based monitoring as support material for legal drafting and for solving the precedent cases of legal monitoring. It is also notable that the statistical value of handset-based monitoring will increase as the penetration of programmable open handsets increases.

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APPENDIX A – RESULTS of BlueTooth measurements

**Table 1. Bluetooth Usage**

| | Users | Percentage of the Panel |
|---|---|---|
| AV - Handsfree | 4 | 1% |
| AV - Headset | 13 | 3% |
| Computer - Desktop | 30 | 6% |
| Computer - Handheld | 4 | 1% |
| Computer - Laptop | 17 | 3% |
| Computer - PalmSize | 2 | 0% |
| Computer - Unclassified | 2 | 0% |
| Misc - Unclassified | 33 | 7% |
| Phone - Cellular | 43 | 9% |
| Phone - SmartPhone | 19 | 4% |
| Any Bluetooth Service (Machine-to-Machine) | 84 | 17% |
| Received Bluetooth Message (Person-to-Person) | 144 | 29% |
| Sent Bluetooth Message (Person-to-Person) | 169 | 34% |

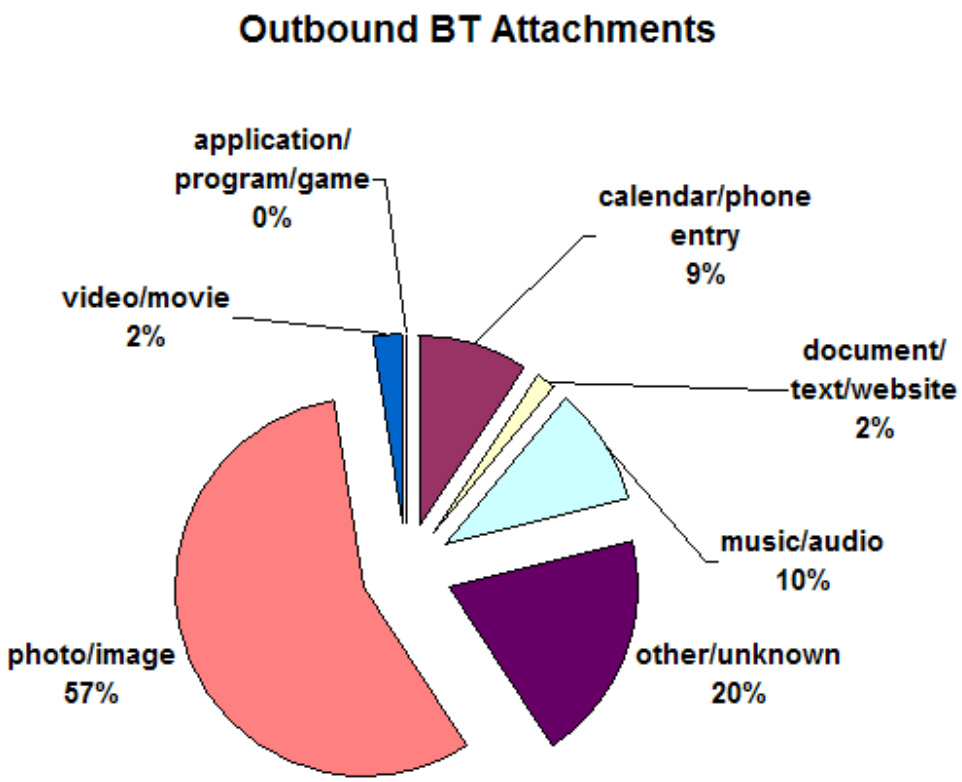


**Figure 1. Outbound Bluetooth Attachments**

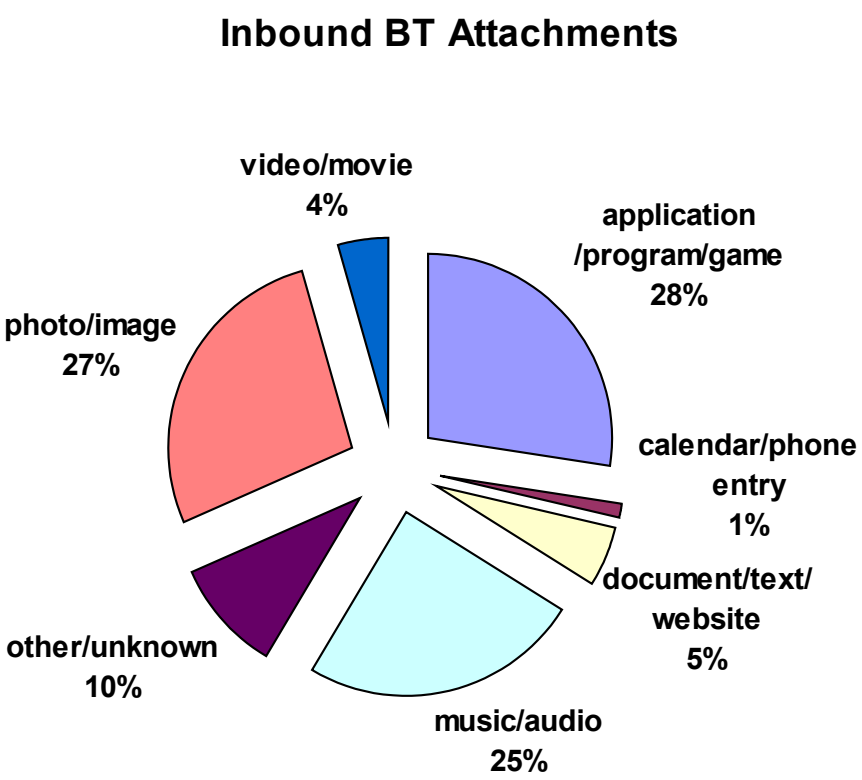


**Figure 2. Inbound Bluetooth Attachments**

## APPENDIX B – RESULTS OF 3RD PARTY APPLICATIONS MEASUREMENTS

**Table 1. Ranking of 3rd Party Applications**

| Application | Panelists Used | Panelists Installed | Median Usage Frequency | Median Usage Intensity |
|---|---|---|---|---|
| www (Opera) | 105 | 0 | 3% | 0.03 |
| MMM | 71 | 0 | 2% | 0.02 |
| Navicore | 71 | 13 | 19% | 0.48 |
| Data Mover | 58 | 0 | 2% | 0.02 |
| FExplorer | 57 | 12 | 7% | 0.16 |
| Bounce | 50 | 2 | 2% | 0.03 |
| Quickword | 49 | 3 | 2% | 0.02 |
| Anti-Virus | 48 | 20 | 14% | 0.18 |
| Mixpix | 45 | 0 | 2% | 0.03 |
| FMRadio | 44 | 0 | 3% | 0.08 |
| ManualVideoEditor | 42 | 0 | 2% | 0.02 |
| Photo Editor | 41 | 1 | 2% | 0.02 |
| Photoring | 41 | 0 | 2% | 0.03 |
| RSPrint | 38 | 2 | 2% | 0.02 |
| Opera | 35 | 9 | 15% | 0.24 |
| DigitalRightsManager | 34 | 0 | 2% | 0.02 |
| Lifeblog | 34 | 3 | 3% | 0.03 |
| AgileMessenger | 30 | 16 | 16% | 0.43 |
| Quickpoint | 28 | 1 | 2% | 0.02 |
| Putty | 26 | 6 | 4% | 0.07 |
| Space Impact | 26 | 1 | 2% | 0.03 |
| Quicksheet | 23 | 3 | 2% | 0.02 |
| Mobile Fun | 21 | 0 | 4% | 0.07 |
| Nokia Sensor | 21 | 11 | 7% | 0.15 |
| NpdViewer | 21 | 0 | 2% | 0.03 |
| RallyProContest | 19 | 0 | 4% | 0.06 |
| Setup | 18 | 6 | 2% | 0.02 |
| NokiaAlbum | 17 | 4 | 2% | 0.03 |
| Pictures | 15 | 0 | 2% | 0.02 |
| irRemote | 14 | 6 | 9% | 0.11 |
| AgentV | 13 | 0 | 2% | 0.03 |
| BTKeyboard | 13 | 0 | 2% | 0.02 |
| ImagePrintApp | 13 | 0 | 2% | 0.02 |
| OggPlay | 13 | 3 | 5% | 0.09 |
| Trivial Pursuit | 12 | 0 | 2% | 0.03 |
| BZW | 11 | 2 | 8% | 0.19 |
| Torch | 11 | 1 | 3% | 0.03 |
| Apulainen | 10 | 0 | 2% | 0.04 |
| BZSav | 10 | 2 | 19% | 2.19 |
| DOOM | 10 | 0 | 4% | 0.05 |

Usage intensity = Application launches / day (accidental launches excluded)
Usage frequency = Percentage of active usage days when application was used

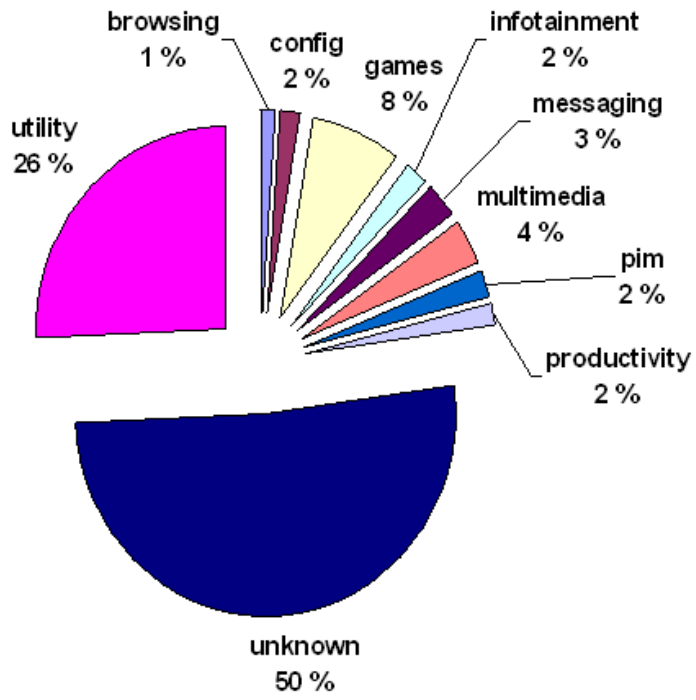


**Figure 1. Distribution of Application Installations**

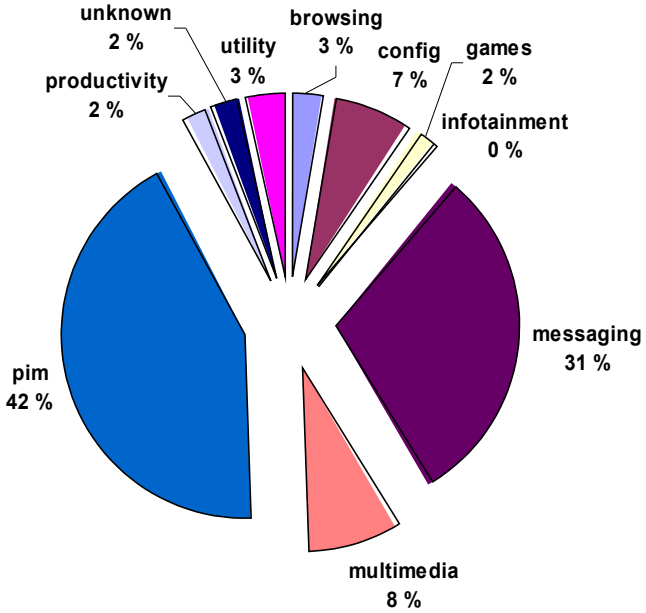


**Figure 2. Distribution of Application Launches**

APPENDIX C – RESULTS OF PACKET DATA TRAFFIC MEASUREMENTS

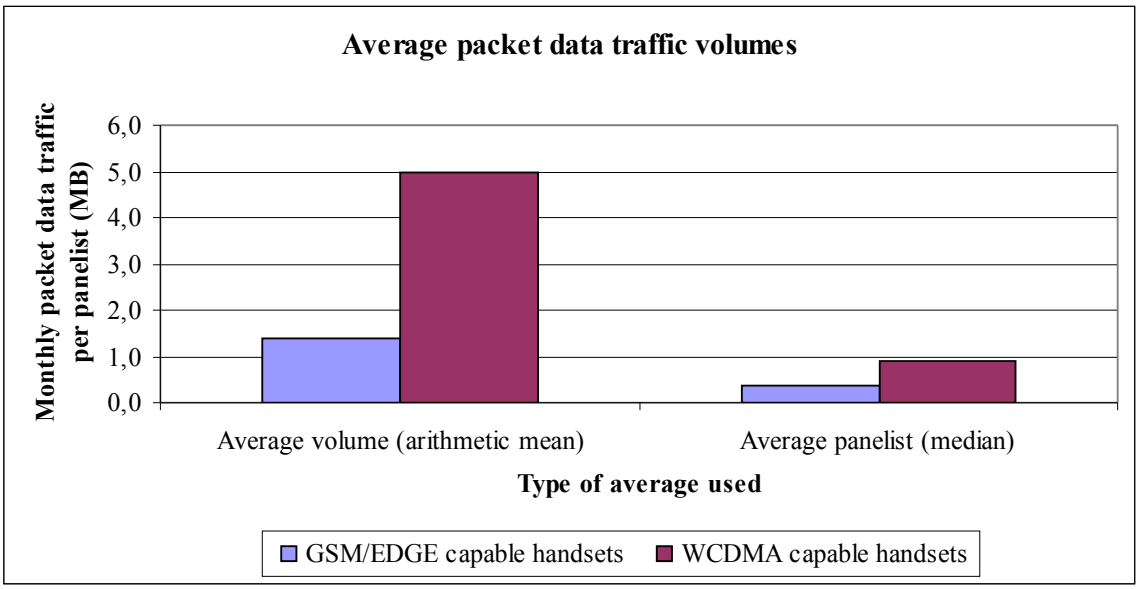


**Figure 1. Average packet data traffic volumes per month per panelist**

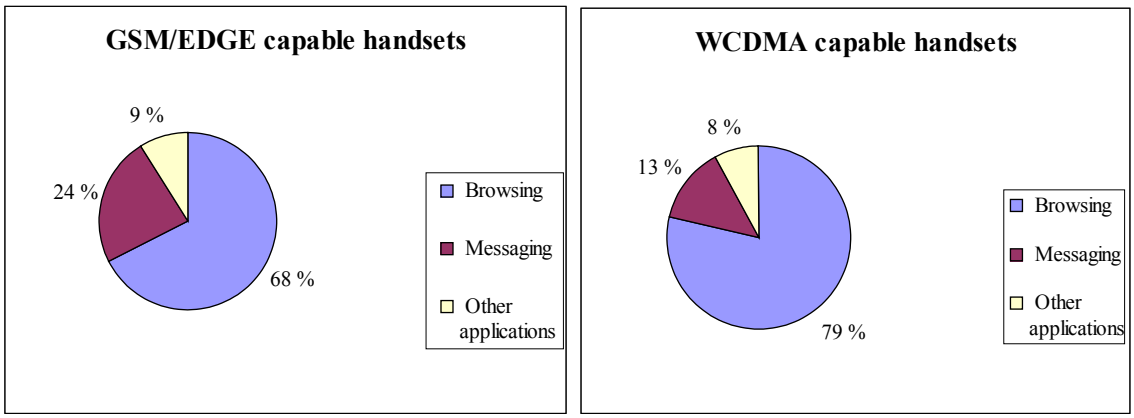


**Figure 2. Average relative distribution of traffic types**