Association for Information Systems
AIS Electronic Library (AISeL)

BLED 2007 Proceedings | BLED Proceedings

2007

Empirical Findings on the Mobile Internet and E-Commerce

Hannu Verkasalo
Helsinki University of Technology, Networking Laboratory, hannu.verkasalo@tkk.fi

20th Bled eConference
eMergence:
Merging and Emerging Technologies, Processes, and Institutions
June 4 - 6, 2007; Bled, Slovenia

Empirical Findings on the Mobile Internet and E-Commerce

Hannu Verkasalo[1]

Helsinki University of Technology, Networking Laboratory
hannu.verkasalo@tkk.fi

Abstract

This paper discusses the evolution of mobile services and associated potential for mobile e-commerce. In particular, the current operator-driven business ecosystems are contrasted to the potential mobile Internet revolution. Critical factors and characteristics of cellular and Internet business ecosystems are identified. Potential for radical changes in mobile services business exists if inducing trends drive the disruptive potential of mobile Internet services. The paper identifies several measures that can be used when projecting to which extent the mobile Internet has emerged. These measures are used in a case example comparing Finnish early-adopter smartphone users between 2005 and 2006. The results indicate that the mobile Internet has not really kicked off in large scale in Finland yet. On the contrary operators have slightly increased their power because handset bundling with mobile subscriptions is now allowed in Finland. The measurement framework can be further utilized both in cross-sectional and longitudinal study settings in evaluating the emergence of the mobile Internet. Accurate studies on mobile e-commerce can also be done. The emergence of the mobile Internet provides a lot of potential for mobile e-commerce to fly.

Keywords: the mobile Internet, operator business, smartphones, mobile e-commerce

1 Introduction

The number of mobile subscribers in the world has for long grown faster than the number of Internet users (see Figure 1). According to Nokia's estimations, the number of cellular subscriptions is likely to surpass three billion in 2008 (Nokia 2005). The number of Internet connections is much lower, about 1 billion in 2005

[1] hannu.verkasalo@tkk.fi
Helsinki University of Technology
Networking Laboratory
P.O. Box 3000 FIN-02015, FINLAND

(Computer Industry Almanac Inc. 2005), and the growth in the number of fixed broadband connections is much slower. It is no surprise that industry experts generally believe that in many developing countries people get their first user experience with the Internet through a mobile handset. In developing countries wireless infrastructure is built in locations where no wired telecom access exists, mainly because it is so much cheaper to do so (Banerjee & Ros 2004; Madden et al. 2004).

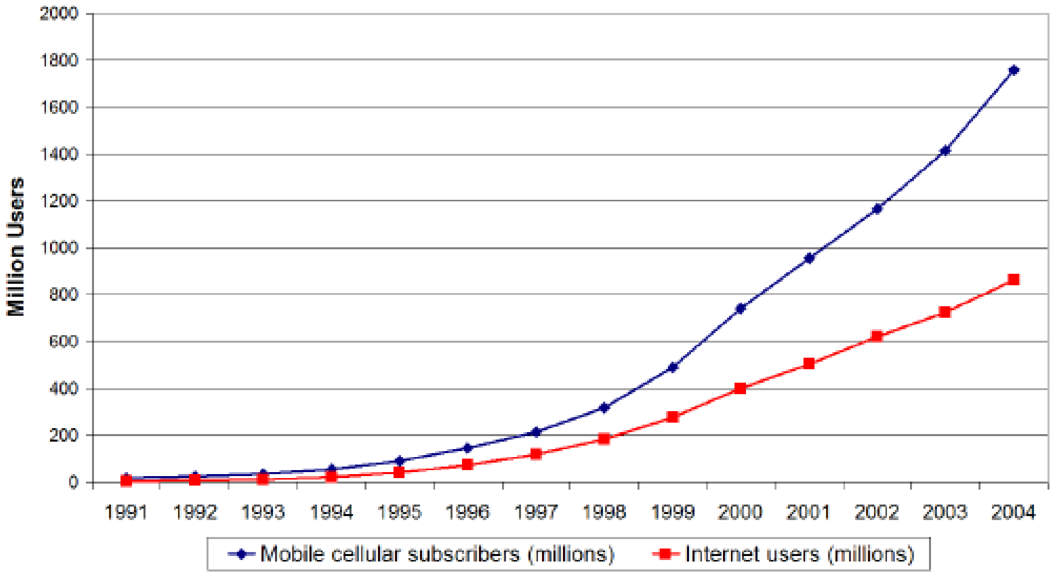

Figure 1 - Number of cellular subscribers and Internet users (adapted from ITU 2006)

Mobile service ecosystems are much operator driven today. In some markets such as Japan and the U.S. operators distribute terminals, charge and bill the customer, deploy services, and manage both the cellular access network and the network core. In general, mobile operators pursue vertically oriented strategies. Similarly handset vendors have focused on developing and manufacturing terminals as cheaply as possible, without significantly taking part in the mobile services business. Few specialized mobile service or content houses exist, with the exception of Japan and NTT DoCoMo's I-mode. Legacy cellular services mostly include voice and simple messaging services, such as SMS. These services still represent most of cell phone usage (Verkasalo 2007b).

The world of Internet has faced a much different industry evolution. Instead of network centricity (cellular operators have still retained much of the control and intelligence in the network), the Internet has leveraged network edge based innovation and open standardized interfaces. The all-IP movement is taking place (Alahuhta et al. 2004). The economics of information societies, pushed by the Internet evolution, are much different from the economics of many other industries (Shapiro and Varian 1998).

This paper discusses the differences between current mobile service ecosystems and corresponding Internet ecosystems (for the metaphor business ecosystem, refer to Moore 1993). An ecosystem is here defined as a network of actors who deliver the service to the end-user in a collaborative manner thus creating value-added for the whole ecosystem. Different ecosystems might be competing (e.g. airline alliances against each other) or complementary overlapping (e.g. the entertainment industry ecosystem collaborating with electronics ecosystem in agreeing on future DVD standards). Ecosystems and other metaphors that help us in understanding complex industry structures are needed when attempting to take a holistic look on industry evolution without focusing solely on one firm only (Afuah 2001).

The mobile Internet is yet to be realized, i.e. the killer mobile services (voice, SMS) are still deployed in a circuit-switched manner with vertically integrated operators controlling the value chain (or value network). The key drivers and bottlenecks for the emergence of a truly mobile Internet and accompanying Internet type service offerings to mobile handsets are identified. Finally critical measures for identifying the extent of the mobile Internet emergence are suggested and deployed in a case study on the Finnish mobile service market in 2005 and 2006.

2 Emergence of the mobile Internet

2.1 Industry structure and business ecosystems

Porter (1980) first modeled industry structures through his famous *value chain* framework. In the value chain framework Porter emphasized the different stages that are needed in delivering a final good to the customer from raw materials. In addition to core functions such as operations and sales, support functions such as R&D are typically needed in the process. Porter defined vertical integration as the extent of value chain coverage taking place inside one firm. In other words, companies that take care of a major part of the value chain are vertically integrated, whereas companies that focus mostly on one part of the value chain only, contracting and outsourcing extensively with external companies, are not vertically integrated. In this paper cellular operators are considered vertically integrated as they do play a role on many layers of the mobile service value chain, whereas Internet companies typically only focus on the service and end-user relationship thus having less vertical integration. According to Kraft (2003) the concept of vertical integration and its link to competitive dynamics is one of the major determinants of industry evolution.

In analyzing the production of complex goods, it is required that the difficulties of complex production and business network management processes are understood correctly (Mitchell and Singh 1996). Mitchell and Singh suggested that many approaches to vertical integration exist, and rather than choosing from two extreme choices companies should consider a whole portfolio of strategic paths that can be taken. The concept of value chain cannot be easily used when analyzing industries (Porter 1985), and therefore a more typical term is *value network* when discussing industry structures. A number of studies applying or discussing the different kinds of value networks exist (Norman & Ramirez 1993; Timmers 1999; Berger et al. 1999), one common thing being that they all consider value-creation dynamics as a more complex process than the value chain framework suggests. In this paper, as the focus is on the whole dynamism in producing and bringing mobile services to customers, the value network ideology with associated company clusters and hot-spots (Pursiainen & Leppävuori 2002) is a natural approach. A business ecosystem is a structured community of companies creating value (Moore 1993), thus leveraging the ideas of value networks. The term ecosystem highlights the idea that all companies involved in the value-creation process are important in keeping the ecosystem alive.

2.2 Cellular and Internet business ecosystems

Mobile services businesses have leveraged vertically oriented business models. Cellular operators have invested in access and core networks, and they typically manage their network quite independently. In some markets so called virtual network operators (MVNOs) have, however, emerged. MVNOs rent capacity from cellular network operators, and run their own subscriber management systems. So called service operators are even more light-weight, they typically e.g. put their brand into the game letting other partners to actually provide all technical infrastructure and network access. (Kiiski 2007) However, the overall cellular business ecosystem is typically vertically integrated. In many countries lots of technical heterogeneity exists (e.g. USA) thus making it difficult to achieve horizontal economies of scale, whereas in some countries operators can lock the customer into their services by controlling e.g. the design of mobile terminals (e.g. Japan, see Funk 2003 and 2006). Monetary streams are still largely controlled by the cellular network operator in all mobile markets.

On the other hand, the Internet world has leveraged much more modular technical infrastructures. PCs have spread all over the world, and computer operating systems in general support various add-on applications and open Internet networking. It is even difficult to define what the Internet is really all about. Email services, WWW browsing, streaming multimedia, instant messaging – they are all Internet services. Because of horizontally oriented technical and business architectures the innovative context is much more open than in cellular business. The technical development has been fast in the Internet. People also increasingly communicate with each other over the Internet, and overlay networks (e.g. P2P and VoIP) are some of the most hyped new trends (Clark et al. 2006). Few monetary streams between fixed access network providers and actual service businesses exist. Innovative business approaches can be seen on the network edge (e.g. Skype leverages add-on service and goods sales, MSN relies on advertising and both Google and Yahoo generate revenue from auctions of search keywords). Figure 2 simplistically compares the different ecosystems.

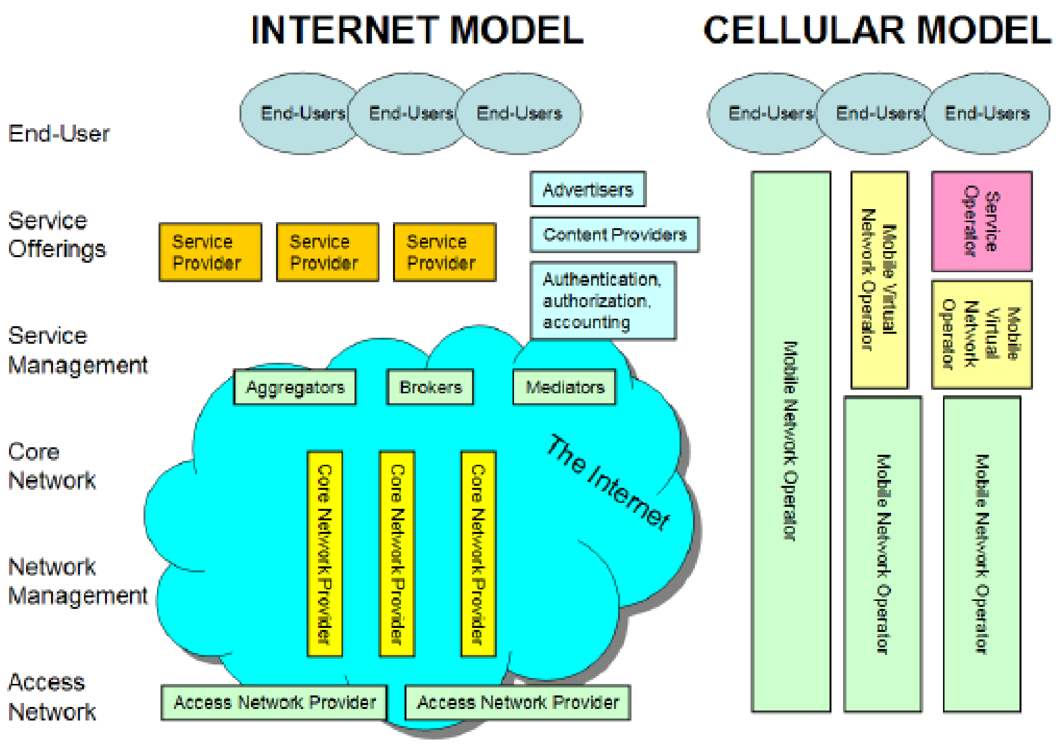

Figure 2 - Internet model vs. cellular model of service delivery

2.3 Problems in the emergence of the mobile Internet

Packet data access has already been technically possible in mobile networks for quite a long time. Thus a possibility for Internet type of service offerings to hit the mobile scene has existed for long. The emergence of the mobile Internet could have brought the business logic of the Internet to the mobile domain, but this has still not happened. According to some recent research results American early-adopter subscribers have well adopted some mobile Internet services (Verkasalo 2007a), though mobile industry with regards to e.g. the deployment of enhanced mobile data networks in the U.S. is generally considered to be lagging some European countries. Looking particularly at the European market, the mobile Internet has not really kicked off (Saarikoski 2006). The Europe driven WAP, for example, was a huge failure (Sigurdson 2001). In Asia NTT DoCoMo has achieved satisfactory demand on Internet type of services, but generally the emergence of the mobile Internet in Asia has not taken off. Difficulties in objectively comparing different markets exist (Saarikoski 2006; Minges 2004).

Funk (2007) suggests that there are two stages in the start-up problem (Economides & Himmelberg 1995) of the mobile Internet. The first stage relates to the initial build-up of the network – attracting the so called critical mass (see e.g. Rohlfs 2001). Micro-payment systems and entertainment content that attract consumer subscribers were the key drivers in the initial Japanese mobile Internet evolution. In Europe lack of "killer applications" and compatibility problems prevented initial user adoption. According to Funk, European operators and service providers focused too much on the enterprise market thus overlooking consumers, whereas the Japanese approach was much different (consumercentric) and therefore much more effective in attracting masses. Funk suggested that

European operators might have had "bounded rationality" (Simon 1955) when planning conservatively for the evolution of mobile services industry. Japanese successfully introduced micro-payment systems through which mobile Internet services could be easily retrieved. As Europeans struggled with standard setting (WAP) and compatibility problems, Japanese operators were better controlling the standardization of mobile Internet services and thus quickly provided users with working Internet type solutions.

The Japanese further implemented services through which to retrieve real Internet sites with URLs. In addition, real email services were brought into mobile handsets. Funk (2007) called this as the second stage in the startup problem, and once again Japanese quicker capitalized on network effects. Europeans had a strong legacy on SMS messaging and associated charging systems, and according to Saarikoski (2006) this was the major bottleneck preventing the rise of the mobile Internet in Europe. Saarikoski argued that SMS is not scale-free in the sense of the Internet (Barabási 1999, Buchanan 2002, Strogatz & Watts 1998), which could have explained why it is not suitable for the mobile Internet revolution.

2.4 Disruptive potential of the mobile Internet

Christensen (1997) introduced the idea of disruptive innovation. In the disruptive evolution initially a low cost innovative challenger solution overtakes the dominant market solution though the initial technical performance is inferior to the dominant design. From the business perspective disruptive services are considered as "…new services that create significant changes in a business model" (Barsi 2002). Disruptive services shake dominant business models by introducing new service innovations and at the same time making older services obsolete.

Hardagon (2003) discusses breakthroughs, suggesting that radical innovations emerge typically when e.g. different worlds or paradigms are combined together. From this perspective the mobile Internet is an interesting concept. The mobile industry on the one hand, and the Internet business on the other hand, have both emerged much separately from each other. Both industries generate significant producer and consumer surplus, in other words economic value-added. Radical innovative potential exists if these two worlds are combined together.

Internet services represent potential sources of disruption in the domain of mobile services and e-commerce. As the dominant mobile business models in Europe are largely operatorcentric, the emergence of the Internet type of business logic might decrease the power of operators and thus have an effect on the whole ecosystem. Packet data oriented services provide the biggest venue for disruption, as the packet data interface to the Internet makes it possible for many of the known Internet services to be deployed in mobile handsets. Verkasalo (2007a) called these as fixed Internet spill-over effects.

The Internet type evolution does not simply mean the deployment of Internet-type packet data services in mobile networks. It actually involves a whole new paradigm in doing business in mobile networks. As Figure 2 presents, the Internet model is horizontally layered. This means that the access and core networks are managed separately, and services are provided on top of the network. Various middle-layer actors exist, but the point is that very little vertical integration exists. Overlay networks further utilize the horizontal structure of the Internet (Clark et al. 2006). As the Internet is based on the layered OSI model (Zimmermann 1980), it is no surprise that also the business of the Internet is much horizontally oriented with little vertical linkage between the actors of different layers. If this Internet model evades to the mobile domain, the most extreme outcomes would involve the break-up of the current vertically oriented business ecosystems. Alternative mobile access networks might emerge (e.g. WiFi, WiMAX), the business logic of incumbent cellular operators might change (orientation towards bit-pipe strategies), and services may be deployed on the edge of the network in the fashion of the Internet. Fixed-to-mobile Internet spill-over effects (Verkasalo 2007a) and Internet network externalities (Katz & Shapiro 1985) are likely to drive the emergence of the mobile Internet.

3 Measuring the extent of mobile Internet adoption

This paper has so far discussed the possible drivers and inhibitors of the mobile Internet. Taking now a more objective look, usage-level measures indicating the extent of mobile Internet usage are suggested. The measures are all applicable with a specialized handsetbased mobile service research platform introduced in Verkasalo & Hämmäinen (2007) and Verkasalo (2005). The research platform supports very accurate measurements of mobile subscriber usage-level behavior. Though the panel studies (including several hundred smartphone customers with the monitoring software installed for ca. 2-3 months in a given market) are geared towards early-adopter customers (see e.g. Rogers 1962), they nevertheless tell something about the most advanced usage patterns that might evade to the mass-market domain in the near future. The research method has already been used in comparing panel studies to each other (Verkasalo 2007a).

3.1 Usage-level measures of the mobile Internet potential

Table 2 below identified the key variables in measuring the mobile Internet usage and possible future potential.

Table 1 – Handset-based measures of mobile Internet potential

Measure	Description
Share of add-on application usage out of all smartphone application usage (in application activations)	As open software platform (in the sense that customers can install own applications on the edge of the network like in the PC world) are critical in pushing mobile Internet usage further (with e.g. multimedia and file sharing applications), a viable variable indicating the extent of network edge based customization is the share of add-on application activations to all application activations.
Share of panelists installing add-on applications to mobile handsets	Similarly, the share of panelists installing add-on applications tells about the overall extent of add-on application usage. The higher this share, the closer the smartphone usage to normal computer usage.
Absolute packet data volume / month / user	The overall utilization of packet data access points (measured in data volume) indicates the general extent of packet data service usage that further should correlate with the emergence of the mobile Internet.
Share of panelists using handset browser	As browsing is one of the key accesses to Internet services, the share of panelists using mobile handset browsers should indicate how high a share of people actually have

	explored this possibility in the mobile domain.
Functional packet data distribution (in aggregated data volume)	The functional break-down of packet data volume tells about the type of data traffic flowing in mobile networks. The first Internet services (in the fixed Internet) were all about messaging (email), after which static content emerged (WWW). The newest trends include other kinds of traffic such as P2P (VoIP and file sharing) and multimedia (streaming). By studying the functional distribution of mobile packet data the trends of the mobile Internet can be identified.
Share of public Internet URL retrievals to operator URL retrievals with handset browser	Because handset browsers are used both in retrieving operator-specific content and services (WAP and other operator portals) and in retrieving purely public (WWW) content, the dominance of either one of these domains indicates the relative role of the Internet or cellular business ecosystems. Operators can push their own bookmarks and services if handset bundling is allowed, but on the other hand many customers might adopt truly open Internet-based services if they will.
Share of Internet communication actions to all communication actions (in session activations)	In communication services the usage of legacy cellular operator driven mobile person-to-person services should be compared to challenger Internet person-to-person services such as email, instant messaging and VoIP in order to measure the emergence of mobile Internet communication.
Share of users using mobile Internet communication services	As earlier, the share of users actually using Internet communication services in mobile networks tells about the overall popularity of these challenger services.
Share of users using Internet multimedia services	The share of people using streaming multimedia services indicates whether users have adopted multimedia oriented Internet services (e.g. video streaming, music downloads etc.) or not.

These measures are easy to implement with the handset-based smartphone research platform (Verkasalo & Hämmäinen 2007). The first longitudinal results from the Finnish market utilizing these mobile Internet measures are presented in the chapter below.

3.2 Results of the empirical analysis

A longitudinal smartphone usage study was conducted in Finland. The first dataset is from fall 2005, and the second from fall 2006. Similar recruitment methods were used in both panel studies (that is, SMS messages were sent to targeted Nokia S60 smartphone users). Customers of all three cellular network operators in Finland (Elisa, TeliaSonera, DNA Finland) were recruited to the study. Both panel studies are likely to consist of earlyadopter users. However, the random selection process of panelists in 2006 is similar to 2005. The possible usage-level differences between the datasets should thus reflect marketlevel phenomena and longitudinal trends in the emergence of new (Internet) services. 500 smartphone users from 2005 and 695 users from 2006 are included. For more information about the datasets, please refer to Kivi (2006) and Verkasalo (2007b). The illustrative results of the mobile Internet measurement results between 2005 and 2006 can be found from Appendix A.

In add-on application usage little change can be identified. Non-3G handsets and 3G handsets have been analyzed separately, as new 3G handsets include some add-on applications (not integrated into Nokia's S60 platform) already preinstalled. The results indicate that the overall share of add-on application usage has remained the same (ca. 7%). Therefore no significant movements towards network edge based solutions in terms of application usage can be found. The other chart presents that 43% of panelists had installed applications during the panel in 2005, and in 2006 this share increased only slightly to 44%. Though people seem to satisfactorily use add-on applications, not change over time is identified.

In packet data usage significant increase can be identified in terms of absolute data traffic amount per user. As the chart in Appendix A suggests, the increase in data usage has taken place in all pricing categories. Verkasalo (2007b) also identifies that the higher 3G penetration of 2006 does not bias the results, as also among 3G handset owners the absolute data traffic amounts have increased. Handset bundling was allowed in Finland in April 2006 and at the same time more block-priced and flat-rate data plans were promoted and sold. The pricing together with higher customer awareness towards data services have probably driven absolute packet data usage (Verkasalo 2007b). Although the share of browsing users has remained at 69%, these users generate more data traffic in 2006 than in 2005. In aggregate terms, therefore, data service usage intensity has increased.

In aggregate functional data volume break-down the share of messaging and browsing traffic has decreased from 91.5% to 74.8%. In 2006 the share of multimedia and infotainment packet data categories is significantly higher than in 2005 (17.4% vs. 0.7%). Although the share of multimedia traffic has increased, the biggest increase is in infotainment data traffic which includes predominantly operator-specific applications. Though infotainment applications utilize open packet data access points, they are still controlled by operators and thus do not represent truly Internet-like data service evolution. On the level of URL retrievals no development can be seen, as the share of public Internet URL retrievals has remained approximately on the same level at ~65%. All in all, little signs can be identified indicating that the mobile Internet would have emerged in larger scale in 2006 than in 2005.

In Internet person-to-person services no development can be identified. On the contrary, the usage coverage rates of mobile email (decreased from 23% to 16%) and mobile instant messaging (decreased from 8% to 5%) show that actually operators have been able to push their legacy services and end-users have been less interested in exploring alternative Internet-based communication services in 2006. This shows up also in the relative distribution of Internet vs. cellular communication actions, as in 2005 the share of Internet communications (email, IM, VoIP) was 2.04% and in 2006 only 1.07% (unique communication session initiations were identified for all communication services). Finnish operators launched several packet offers for voice and SMS when 3G handset bundling became legal, and this might have significantly driven the use of legacy mobile person-toperson services instead of new challenger Internet services.

Many of the results indicate that the emergence of the mobile Internet has kicked off partially. Particularly the high share of public URL retrievals, significant improvement in general packet data volume per user, high share of browser users and the increased share of multimedia traffic support the fact that the mobile Internet is already there among earlyadopter users. However, lots of potential for further success exists. What is less promising, no significant development can be identified between 2005 and 2006. Possibly the legalization of 3G handset bundling has temporarily increased the power of operators and this has negatively affected the rise of the mobile Internet. In Verkasalo (2007a) it is suggested that early-adopter customers particularly in the U.S. already widely use e.g. mobile email and instant messaging. It is possible that very low prices of legacy mobile services in Finland have affected the mental models of mobile subscribers, and therefore Finns are not that interested in challenger mobile Internet services as subscribers in some other markets. For example in the U.S. SMS services never really kicked off and thus subscribers easier substitute mobile Internet services for legacy cellular services there (Verkasalo 2007a). In the U.S. fixed-to-mobile Internet service spill-over effects might be stronger. In particular, e.g. the wide popularity of instant messaging among Americans drives its emergence in mobile phones.

4 Conclusion

The emergence of the mobile Internet depends on many factors. In addition to regulation, trends in the evolution of mobile business ecosystems, technical evolution and end-user adoption affect the speed of mobile Internet growth. Lots of disruptive potential exist in the mobile Internet, as the logic of the ecosystem is much different from the current verticallyoriented cellular operator driven mobile ecosystems. If the truly mobile Internet emerges, also the potential for mobile e-commerce increases as was the case with the fixed Internet in the 90s. According to the questionnaire results in Verkasalo (2007b) already 70% of Finnish early-adopter smartphone users have purchased electronic content and 42% services or goods with mobile handsets.

This paper suggests several variables that can be used in measuring the emergence and potential of the mobile Internet. First, measures reflecting the evolution of open mobile handset software platforms and network edge based innovation are presented. Second, several measures indicating both the absolute usage and functional break-down of packet data traffic in mobile networks are presented. Third, comparisons between Internet and legacy cellular communication functions tell something about the substitution of incumbent mobile communication functions by challenger Internet person-to-person services.

Though the results indicate that already promising signs can be seen with regards to the use of packet data and Internet oriented mobile services, no significant development over time between 2005 and 2006 exists. In addition, Finland lags significantly some other markets where early-adopter smartphone users have been studied (see Verkasalo 2007a). Perhaps Finnish subscribers have a mental lock-in to legacy services, and operators have been able to push their own services with handset bundling thus counteracting the emergence of the mobile Internet.

The measures presented in this paper link well to the key drivers and bottlenecks discussed in the qualitative part of the study. In addition, these measures can be used in the future when doing new cross-sectional or longitudinal studies on the evolution of the mobile Internet. Particular focus should be put on studying mobile e-commerce, which might experience a similar boost in mobile networks soon as in the fixed Internet earlier. In terms of mobile e-commerce adoption studies focus should be put on potential bottlenecks (e.g. usability, security) of deploying mobile e-ecommerce, and the e-commerce spill-over effects from fixed (e.g. already implemented WWW-based services such as eBay) to mobile should be assessed.

References

Afuah, A. 2001. Dynamic boundaries of the firm: Are firms better off being vertically integrated in the face of a technological change? *Academy of Management Journal, 44 (6), 1211-1220.*

Alahuhta, P. & Jurvansuu, M. & Pentikäinen, H. 2004. Roadmap for network technologies and services. Tekes, Helsinki, Finland, *Technology Review 162/2004*. ISBN 952-457-176-5.

Anderson, P. & Tushman, M. 1990. Technological discontinuities and dominant designs: A cyclical model of technological change. *Administrative Science Quarterly, 35, 604–633.*

Anderson, N. 2007. Skype asks FCC to open up cellular networks. ARS Technica, February 21, 2007. http://arstechnica.com/news.ars/post/20070221-8895.html. Referred 22.2.2007.

Banerjee, A. & Ros, JA. 2004. Patterns in global fixed and mobile telecommunications development: a cluster analysis. *Telecommunications Policy (2004), vol 28, no 2.*

Barabási, AL. 2003. *Linked, How Everything Is Connected to Everything Else and What it Means for Business, Science, and Everyday Life*. London, Penguin Books Ltd, 2003.

Barsi, T. 2002. Disruptive technology vs. disruptive applications. Telephony Online. http://telephonyonline.com/news/telecom_disruptive_technology_vs/index.html. Referred 6.6.2006.

Berger, S. & Sturgeon, T. & Kurz, C. & Voskamp, U. & Wittke, V. 1999. *Globalization, value networks and national models.* Memorandum prepared for the IPC Globalization Meteting, October 8 (1999), MIT.

Buchanan, M. 2002. *Nexus – small worlds and the groundbreaking theory of networks.* W.W. Norton 6 Company Inc, New York, 2002

Christensen, CM. 1997. *The Innovator's Dilemma*. Harvard Business School Press.

Clark DD. & Lehr W. & Bauer SJ. & Faratin P. & Sami R. & Wroclawski J. 2006. Overlay Networks and Future of the Internet. *Journal of Communications and Strategies*, 3(63), pp 1-21, 2006.

Computer Industry Almanac Inc. 2005. Worldwide Internet Users Top 1 Billion in 2005. http://www.c-ia.com/pr0106.htm. Referred 20.2.2007.

Economides, N. & Himmelberg, C. 1995. Critical mass and network evolution in telecommunications. In G. Brock (Ed.), *Towards a competitive telecommunications industry: Selected papers from the 1994 telecommunications policy research conference*.

Funk, J. 2003. Standards, dominant designs and preferential acquisition of complementary assets through slight information advantages. *Research Policy, 32, 1325–1341.*

Funk, J. 2006. Mobile phone industry: A microcosm of deregulation, globalization, and technological change in the Japanese economy. In R. Taplin (Ed.), *Japanese Telecommunications Market and Policy in Transition*. London: Routledge.

Funk, JL. 2004. *Mobile Disruption - the technologies and applications driving the mobile internet*, Wiley January 2004.

Hargadon, A. 2003. *How Breakthroughs Happen - The Surprising Truth About How Companies Innovate,* Boston Massachusetts, Harvard Business School Press, 2003.

Harrigan, KR. 1984. Formulating vertical integration strategies. *Academy of Management Review, 9 (4), 638-652.*

ITU. 2006. Key Global Indicators for the World of Telecommunication Service Sector. http://www.itu.int/ITU-D/ict/statistics/at_glance/KeyTelecom99.html. Referred 20.2.2007.

Kallasvuo, OP. 2006. Future Direction for Nokia. Presentation held at Nokia Capital Market Days, 28.11.2006, Amsterdam. http://media.corporate-ir.net/media_files/irol/10/107224/Oli_Pekka.pdf. Referred 20.2.2007.

Karlson, B. & Bri, A. & Link, J. & Lönnqvist, P. & Norling, C. 2003. *Wireless Foresight: Scenarios of the Mobile World in 2015*. John Wiley and Sons, 2003.

Katz, ML. & Shapiro, C. 1985. Network Externalities, Competition, and Compatibility. American Economic Review. *American Economic Association, vol. 75(3), pages 424-40, June*.

Kiiski, A. 2007. *Impact of Virtual Operators on Mobile Market.* Licentiate's Thesis. Networking Laboratory. Helsinki University of Technology.

Kraft, J. 2003. Vertical structure of the industry and competition: An analysis of the evolution of the infocommunications industry. *Telecommunications Policy, 27, 625-649*.

Kumar, RKR. 2006. International Mobile Roaming Alternatives: An Impact Analysis. Presented at World Telecommunications Congress 2006 - Emerging Telecom Opportunities. WTC, Budapest, Hungary, 1-3 May, 2006.

Madden, G. & Coble-Neal, G. & Dalzell, B. 2004. A dynamic model of mobile telephony subscription incorporating a network effect. *Telecommunications Policy (2004), vol 28, no 2*.

Minges M. 2005. Is the Internet Mobile? Measurements from the Asia-Pacific region. *Telecommunications Policy 29 (2005) 113–125.*

Moore, JF. 1993. Predators and pray: A new ecology of competition. *Harvard Business Review, May-June, 75-86.*

Nokia. 2005. Nokia defines strategy and targets for continued profitable growth. Press release, 1.12.2005. http://www.nokia.com/A4136002?newsid=1023902. Referred 20.2.2007.

Normann, R. & Ramirez, R. 1993. From value chain to value constellation: Designing interactive strategy. *Harvard Business Review, July-August 1993, 65-77.*

Ordinini, A. & Dedrick, J. & Kraemer, HL. 2006. Medion: The ”Orchestrator” Business Model. PCIC (Personal Computing Industry Center), The Paul Merage School of Business, University of California, Irvine.

Porter, M. 1980. *Competitive Strategy*, Free Press, New York, 1980.

Porter, M. 1985. *Competitive Advantage*, Free Press, New York, 1985.

Pursiainen, H. & Leppävuori, I. 2002. *Analysis of the Finnish mobile cluster - Any potential in mobile services.* Helsinki: Ministry of Transport and Communications, Finland.

Rogers, EM. 1962. *Diffusion of Innovation*. New York, NY: New York: Free Press.

Rohlfs, J. 2001. *Bandwagon effects in high-technology industries*. Cambridge, MA: MIT Press.

Saarikoski, V. 2006. *The Odyssey of the Mobile Inter*net. Doctoral Dissertation. University of Oulu, Finland.

Shapiro, C. & Varian, HR. 1998. *Information Rules: A Strategic Guide to the Network Economy*. Boston, MA: Harvard Business School Press.

Sigurdson, J. 2001. WAP OFF - Origin, Failure and Future. Prepared for the Japanese-European Technology Studies (JETS), October 9, 2001, University of Edinburgh.

Simon, H. 1955. A behavioral model of rational choice. *Quarterly Journal of*

Economics, 69, 99–118.
Strogatz, SH. 2001. Exploring complex networks. *Nature vol. 410, pp 268-276, March 2001*
Timmers, P. 1999. *Electronic commerce - Strategies and models for business-to-business trading.* London: John Wiley.
Verkasalo H. 2005. *Handset-Based Monitoring of Mobile Customer Behavior*. Master's Thesis Series. Networking Laboratory. Department of Electrical and Telecommunications Engineering. Helsinki Universityof Technology.
Verkasalo, H. & Hämmäinen, H. 2007. A Handset-Based Platform for Measuring Mobile Service Usage. *INFO: The Journal of Policy, Regulation and Strategy. Vol 9 No 1, 2007.*
Verkasalo, H. 2007a. *A Cross-Country Comparison of Mobile Service and Handset Usage*. Licentiate's thesis, Helsinki University of Technology, Networking Laboratory, Finland.
Verkasalo, H. 2007b. Insights on the Evolution of the Finnish Mobile Service Market. Submitted for publication at Conference on Telecommunication Techno-Economics CTTE) 2007, 14-15 June 2007, Helsinki, Finland.
Vesa, J. 2005. *Mobile Services in the Networked Economy*. IRM Press, Hershey, PA, USA.
Zimmermann, H. 1980. OSI Reference Model — The ISO Model of Architecture for Open Systems Interconnection. *IEEE Transactions on Communications, vol. 28, no. 4, April 1980, pp. 425 - 432.*

Appendix A – Mobile Internet measurement results from Finland 2005-2006

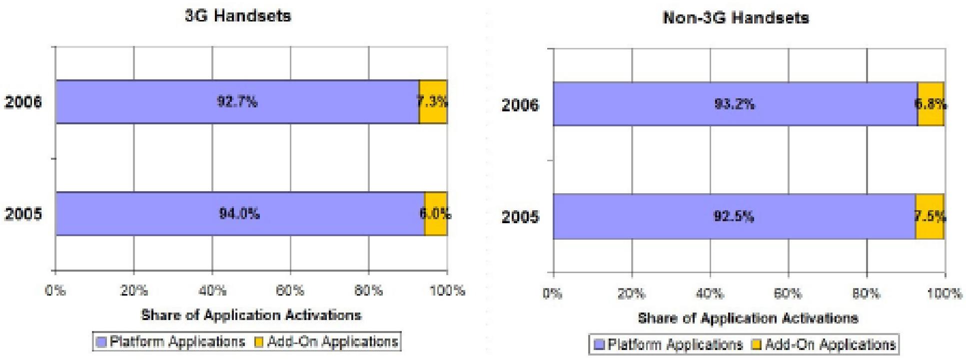

Figure 3 - Share of add-on application usage to all application usage

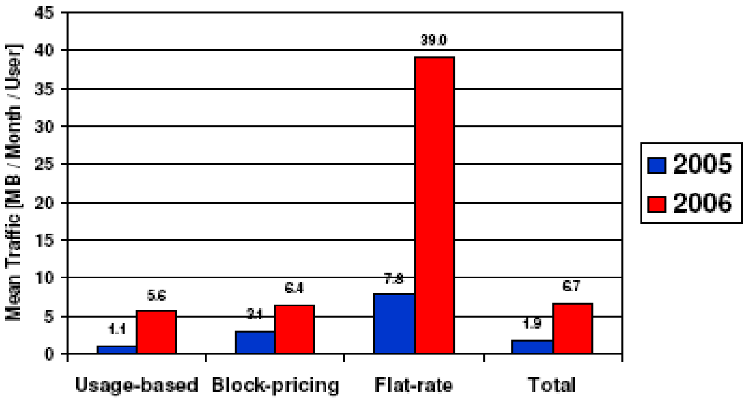

Figure 4 - Absolute packet data usage per user

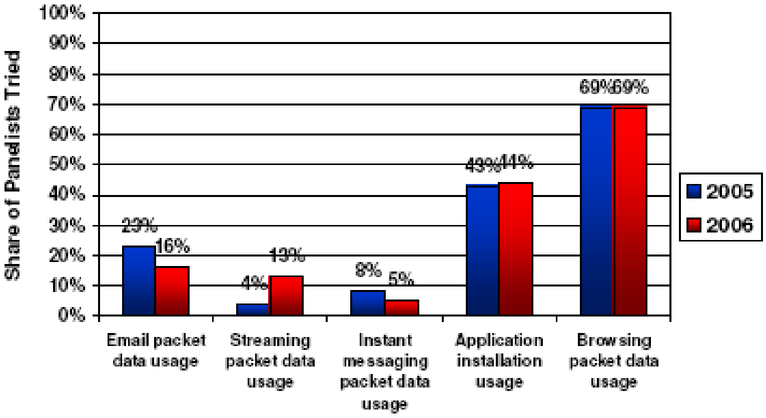

Figure 5 - Adoption of Internet-related services

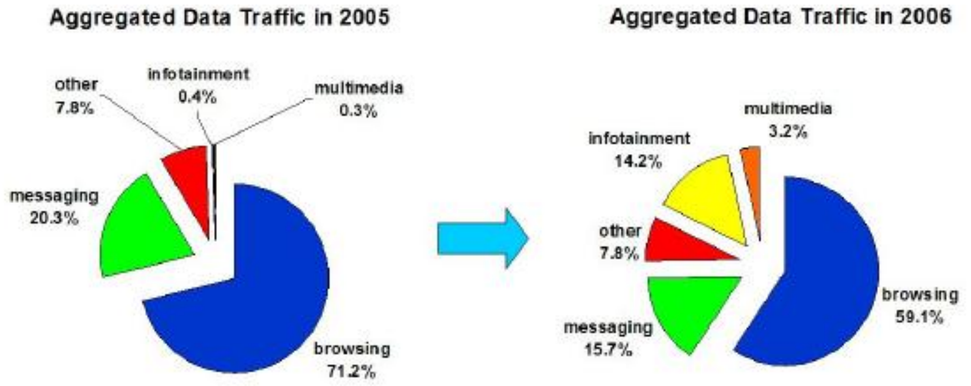

Figure 6 - Functional break-down of packet data traffic

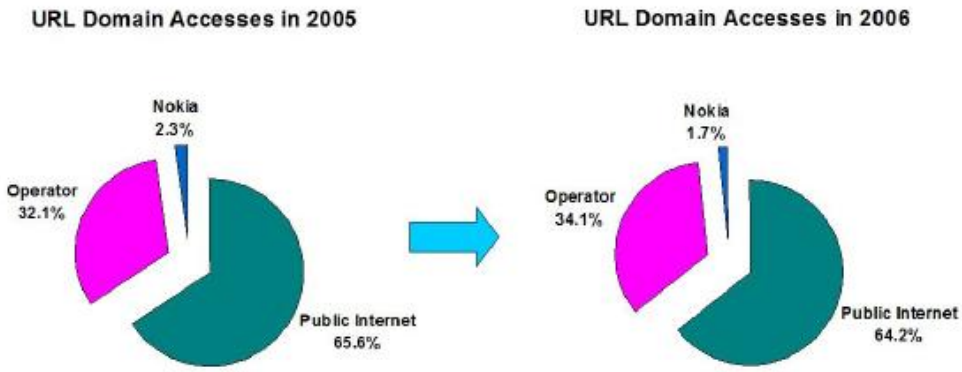

Figure 7 - Distribution of URL retrievals

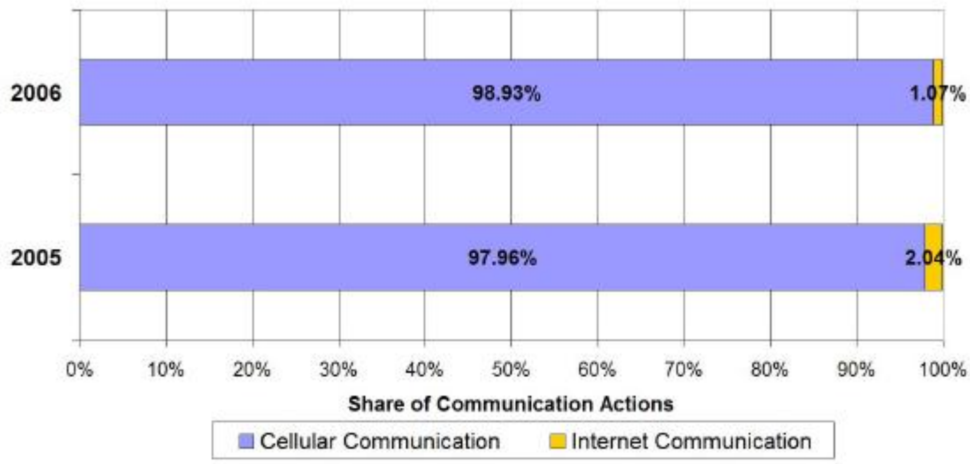

Figure 8 - Cellular vs. Internet communication actions

Vitae – Hannu Verkasalo

Hannu Verkasalo works as a research scientist at Helsinki University of Technology, Finland. Hannu Verkasalo has published several conference and journal papers on the evolution of the mobile service market, and currently he is pursuing a doctoral dissertation on the emergence of the mobile Internet. Verkasalo has particularly focused on empirical mobile service research utilizing the recently developed handset-based research method. In addition to research work, Hannu Verkasalo gives lectures on network economics, operator business and telecommunication regulation and additionally consults companies working in the wireless industry.