HELSINKI UNIVERSITY OF TECHNOLOGY
Faculty of Information and Natural Sciences
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Mobile Services and the Internet - A Study of Emerging Business Models

Licentiate thesis

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Instructor D.Sc.(Tech.) Sakari Luukkainen

HELSINKI UNIVERSITY OF TECHNOLOGY **ABSTRACT OF LICENTIATE THESIS**
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Usage of mobile data will grow exponentially, but the average revenue per subscriber (ARPU) for the data will show only a linear increase. The total ARPU, including voice, SMS and data income, is steadily decreasing. On the other hand, the mobile operators are still very profitable, but the future can be more challenging. New internet competitors are agile and utilize new business models to compete with the incumbents. So far, mobile operators have used to run their business according to the closed, walled garden approach, but lately, more open alternatives have gained popularity. Compared to the closed model, the other extreme is an open, a bit pipe, model. In this model operators provide their customers with just a data connection, while the mobile services come from the Internet. However, based on the literature review, an optimal solution can be found from a hybrid model. The study explores novel business models that enable a hybrid model for the mobile industry. Ideas such as MSC Server, pull-messaging, mobile P2P, mobile Web 2.0, Open Telco and creative revenue models are elaborated.

The main research method of this licentiate thesis was limited to the literature review. The main research question asked was whether the hybrid model can compensate for the ARPU decline. The results of the literature review and the publications indicate that the answer is positive. The Open Telco concept is the key component in the hybrid model. It is supported by suitable internet technologies and revenue models, where the specific requirements of the wireless environment have been identified. The success of the IP Multimedia Subsystem is still unclear. Instead, the MSC Server with open APIs provides an evolutionary alternative for the mobile service core. These results should be validated in the future research by experimentations. Moreover, the proposals should be tested in the field by real end users. Access to the real mobile operator data would be essential to make the reliable conclusions. In addition, the research should be extended to include regulation and human factors, since the privacy questions must be solved before the mobile networks can be opened.

Keywords: ARPU, business model, hybrid model, long tail, mobile P2P, mobile services, mobile web 2.0, open API, open telco, revenue model, STOF, user generated content

TEKNILLINEN KORKEAKOULU Informaatio- ja luonnontieteiden tiedekunta Tietotekniikan laitos	**LISENSIAATINTUTKIMUKSEN TIIVISTELMÄ**
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Mobiilidatan kokonaisvolyymin ennustetaan kasvavan eksponentiaalisesti, mutta vastaava tilaajan keskimääräinen kuukausituotto (ARPU) kasvaa vain lineaarisesti. Samaan aikaan kokonais-ARPU, joka sisältää myös puhe- ja tekstiviestituotot, on tasaisessa laskussa. Toisaalta matkapuhelinoperaattorit tekevät edelleen hyvää tulosta, mutta tämän vaiheen ennakoidaan pian päättyvän. Internet-kilpailijat ovat ketteriä ja hyödyntävät uudenlaisia liiketoimintamalleja, jotka haastavat nykyiset valtaoperaattorit. Tähän saakka operaattorit ovat soveltaneet liiketoiminnassaan suljettua strategiaa, mutta viime aikoina avoimuus on saanut enemmän jalansijaa. Äärimmäisenä vaihtoehtona suljetulle näkökulmalle on nk. bittiputki-lähestymistapa, jossa operaattorit tarjoavat asiakkailleen vain datayhteyden, palveluiden tullessa internetistä. Kirjallisuusselvityksen mukaan optimaalinen ratkaisu löytyy kuitenkin näiden vaihtoehtojen väliltä, hybridimallista. Tutkielma esittelee lähestymistapoja, jotka tukevat matkapuhelinteollisuuden siirtymistä hybridimalliin. MSC-palvelin, hakuviestintä, mobiili vertaisverkko, mobiili web 2.0, avoin tietoliikennejärjestelmä sekä uudet ansaintamallit ovat esimerkkejä ideoista, jotka tukevat hybridiajattelua.

Tämän lisensiaattityön päätutkimusmenetelmä perustuu kirjallisuusanalyysiin. Tutkimuksen pääkysymys on voiko hybridimalli kompensoida ARPU:n pienenemisen. Kirjallisuusselvitys sekä aiheeseen liittyvät julkaisut osoittavat, että vastaus on positiivinen. Avoin tietoliikennejärjestelmä on avainkomponentti hybridi-mallissa. Sitä tukevat internet-teknologiat ja -ansaintamallit, joissa on otettu huomioon langattoman ympäristön erityisvaatimukset. IMS:n menestys on vielä hyvin epäselvää. Sen sijaan avoimilla rajapinnoille varustettu MSC-palvelin tarjoaa kehittyvän vaihtoehdon matkaviestintäpalvelujen tarjoamiselle. Kaikki nämä tulokset on kuitenkin varmennettava kokeellisilla jatkotutkimuksilla, joissa on mukana aitoja loppukäyttäjiä. Pääsy operaattoreiden omistamaan tilaajatietoon olisi ensiarvoisen tärkeää luotettavien loppupäätelmien tekoa varten. Lisäksi regulaatiokysymykset ja inhimilliset tekijät tulisi lisätä tutkimuskehykseen, koska yksityisyyden suojan haasteet on ratkaistava ennen kuin mobiiliverkot voidaan lopullisesti avata.

Avainsanat: ansaintamalli, ARPU, avoimet rajapinnat, avoin tietoliikennejärjestelmä, hybridimalli, käyttäjän luoma sisältö, liiketoimintamalli, matkaviestintäpalvelut, mobiili vertaisverkko, mobiili web 2.0, pitkä häntä, STOF

Foreword

This licentiate is an article dissertation. It consists of one journal, written in 2000, five conference papers, written and presented between years 2006 and 2009, and a preface that was created in 2009. The contents of the thesis is based on the post graduate studies that were carried through in the Helsinki University of Technology, in the Department of Computer Science and Engineering, mainly in 2005 and 2006, and also my work experience gathered in Nokia Networks between years 1994 and 2007, and correspondingly in Nokia Siemens Networks between years 2007 and 2009.

First of all, I want to thank professor Antti Ylä-Jääski, who acted as a supervisor for the thesis. He inspired me to start the post graduate studies in the first place, and gave valuable advices for the selection of the courses and planning of the research topics.

Secondly, I owe the warmest thanks to lecturing researcher Sakari Luukkainen, who was the instructor of the thesis. His passion and comments essentially improved the quality of the thesis. Sakari was also the co-author in two publications giving excellent ideas for the research agenda.

Thirdly, I give my gratitude to Lauri Oksanen, Head of Research and Technology in Nokia Siemens Networks. He acted as the external reviewer of the thesis. In addition, Lauri was my exacting but fair superior between years 2001 and 2006. He determinedly encouraged me to continue the self development, also by the post graduate studies. I also owe thanks to my old services research team, who continuously sparred my thoughts and created an innovative atmosphere.

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List of publications

I. Subbiah, B & Raivio, Y 2000, 'Transport architecture evolution in UMTS/IMT-2000 cellular networks', *International Journal of Communications Systems*, no. 13, pp. 371-385.

II. Raivio, Y & Addams-Moring, R 2006, 'Mobile Emergency Announcements with Really Simple Syndication (RSS 2.0)', *Proceedings of the 3rd International ISCRAM Conference*, Van de Walle, B & Turoff, M (eds), Newark, NJ, May 14-17, 2006, pp. 164-171.

III. Raivio, Y 2006, 'Peer-to-Peer Architecture for Cellular Networks', *Proceedings of the ICIN 2006 - the 10th International Conference on Convergence in Services, Media and Networks*, Adera Service, Bordeaux, France, May 29 - June 01, 2006, pp. 340-345.

IV. Raivio, Y & Luukkainen, S 2006, 'Digital Rights Management in the Mobile Environment', *Proceedings of ICE-B 2006 - International Conference on E-business*, INSTICC, Setúbal, Portugal, August 7 - 10, 2006, pp. 182-185.

V. Raivio, Y 2008, 'The Broker - A Solution for Global Mobile Services', *Proceedings of the ICIN 2008 - the 11th International Conference on Services, Enablers and Architectures Supporting Business Models for a New Open World*, NeuStar Secretariat Services, Bordeaux, France, October 20 - 23, 2008.

VI. Raivio, Y, Luukkainen, S & Juntunen, A 2009, 'Open Telco: A New Business Potential', *Proceedings of the 5th ACM Mobility Conference 2009*, ACM, Nice, France, September 2 - 4, 2009.

Contribution reports

I. Yrjo Raivio wrote chapters 2 and 5, and was a secondary author for chapters 1, 4, 7 and 8.

II. Considering that in the future this paper may be used as a part of a thesis, we volunteer this information. Guarantor: Yrjo Raivio (YR). Scientific contribution and participation in the writing: Ronja Addams-Moring (RAM) suggested that students evaluate different ICTs for MEA and MCEA suitability. YR suggested that he evaluates RSS 2.0. RAM tutored YR when he did the literature analysis for and wrote the first full-length draft of this paper. YR selected the issues to be addressed and did the analysis of all the addressed XML based data formats mostly independently. RAM's primary responsibility was aligning the work with emergency management realities, especially with MEA and MCEA requirements. Based on discussions with YR, RAM edited the whole paper before submission. After the reviews, both YR and RAM edited the paper based on reviewer comments. Accepting of text: Both authors have accepted the text of this final paper via e-mail on March 15, 2006. Acknowledgements: We thank Göran Schultz and Jaakko Rajaniemi for their comments on the first draft.

III. Yrjo Raivio was the only author.

IV. Yrjo Raivio was the primary author of the chapters 2, 3, 4 and 5. Sakari Luukkainen wrote the chapter 1.

V. Yrjo Raivio was the only author. Acknowledgements: The author would like to thank Marcus von Garssen, Sami Mäkeläinen, Frank Oehler, Ville Syrjänen and several other colleagues from Nokia Siemens Networks, who have helped to improve the content of the paper.

VI. Yrjo Raivio was the primary author of chapters 1, 3 and 4. Sakari Luukkainen wrote the chapter 2.1 and Antero Juntunen wrote the chapter 2.2.

Abbreviations

AAL2	ATM Adaptation Layer type 2
AJAX	Asynchronous communication, Java, and XML
ARPU	Average Revenue per User
C2C	Consumer-to-consumer
CBS	Cell Broadcast Service
CDI	Critical Design Issue
CPM	Cost per Millenium
CS	Circuit Switched
CSF	Critical Success Factor
CSV	Core Strategic Vision
DoS	Denial of Service
DRM	Digital Rights Management
GSMA	GSM Association
HLR	Home Location Register
IMS	IP Multimedia Subsystem
IN	Intelligent Network
IP	Internet Protocol
IPR	Intellectual Property Rights
ISP	Internet Service Provider
IWU	Interworking Unit
LTE	Long Term Evolution
M2M	Machine-to-machine
MEA	Mobile Emergency Announcement
MM	Mobility Management
MMS	Multimedia Messaging Service
MP2P	Mobile Peer-to-Peer
MSC	Mobile services Switching Centre
MSS	MSC Server
MTI	Management of Technological Innovation
MVNO	Mobile Virtual Network Operator
NGN	Next Generation Networks
P2P	Peer-to-Peer
PI	Push Initiator
PoC	Push over Cellular
PPG	Push Proxy Gateway
QoS	Quality of Service
RAN	Radio Access Network
RCS	Rich Communication Suite
REST	Representational State Transfer
RPV	Resources, Processes and Values
RSS	Really Simple Syndication
SDK	Software Development Kit
SDP	Service Delivery Platform

SIMPLE	Session Initiation Protocol for Instant Messaging and Presence Leveraging Extensions
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SME	Small and Medium Enterprise
SMS	Short Message Service
SMSC	Short Message Service Centre
SOA	Service-oriented Architecture
SOAP	Simple Object Access Protocol
SSME	Services Sciences, Management, and Engineering
STOF	Service, Technology, Organization, and Finance
UDDI	Universal Description, Discovery, and Integration
UGC	User Generated Content
VCE	Value Chain Evolution
VoIP	Voice over Internet Protocol
WAP	Wireless Application Protocol
WS	Web Services
WSDL	Web Services Description Language
XML	Extensible Markup Language
XMPP	Extensible Messaging and Presence Protocol

1. Introduction

1.1. Research background

The principle of network neutrality is one of the internet corner stones. Network neutrality includes two different concepts. The first concept means that the network does not discriminate between the service providers, while the second concept, protocol independence, means that, in terms of quality of service (QoS), all protocols are equally treated. In the Internet network neutrality has shown its strength, but the mobile domain has not followed the same path. This fact was highlighted, for example, by professor Raymond Steele, who opened the 3G2001 conference in London year 2001. He said that everybody should be able to create services over any access network. In those days, on the eve of the dotcom collapse, the real meaning of the sentence was not fully understood, but surprisingly, eight years later, several individuals, organizations and companies are still resisting this natural idea.

The lack of a network neutrality approach is just one example of the problems that the mobile industry carries within. So far, this policy has not been a problem, because the mobile operators run one of the most profitable of the industry sectors. As proof, a medium size Scandinavian fixed and mobile operator, TeliaSonera, just announced a profit of roughly 900 million euro from the 3rd quarter in 2009 (TeliaSonera 2009). The number of mobile operator subscribers has grown steadily, especially on the developing markets, bringing solid income from voice and text messaging services. Finally, also data consumption seems to explode. According to the forecast by Cisco (2009), the accumulated mobile data growth is exponential. The main component of the increase is the video. Audio represents voice over IP (VoIP) portion, while P2P category includes SMS, email and P2P data traffic. The last category, data holds all the rest of data services. See Figure 1.

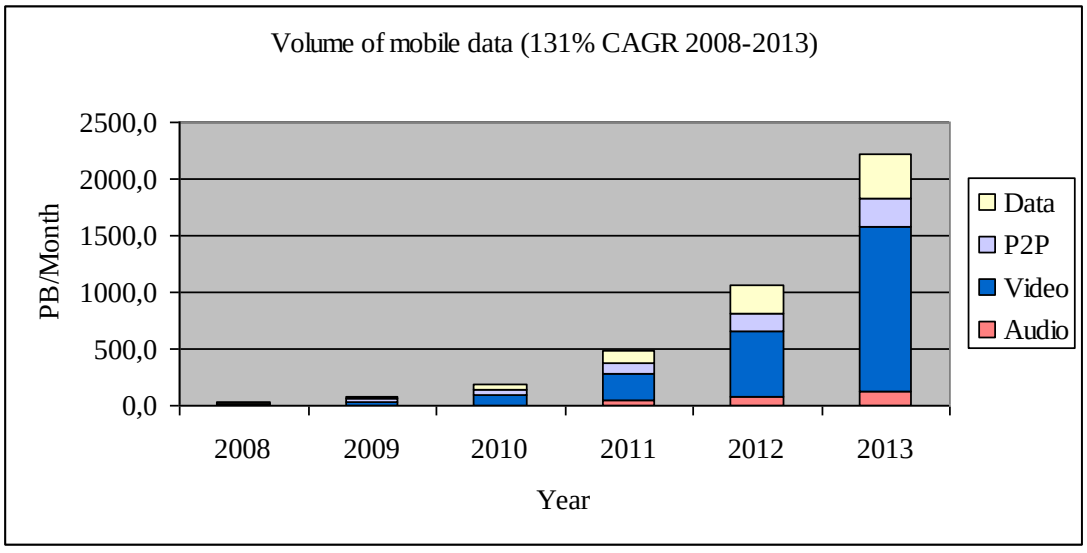

Figure 1. Mobile data growth forecast (Cisco 2009, p. 2).

On the other hand, mobile data revenues are not growing exponentially. Instead, the average revenue per user (ARPU) has grown only linearly between the years 2002 and 2007, and the forecast for the following five years does not show any radical increase for mobile data turnover. The main reason for this unwanted development is the dominant mobile data business model that is based on the flat rate approach. The fixed price will remove the dynamic element from revenue behavior. Figure 2 shows a typical non-voice ARPU curve in Western Europe (Analysys 2007). It is noticeable that Short Message Services (SMS) revenues are shown in this diagram on its own category. At the moment SMS bring most of the data revenues, but towards the end of the forecast period, video and other data categories will gain financial importance.

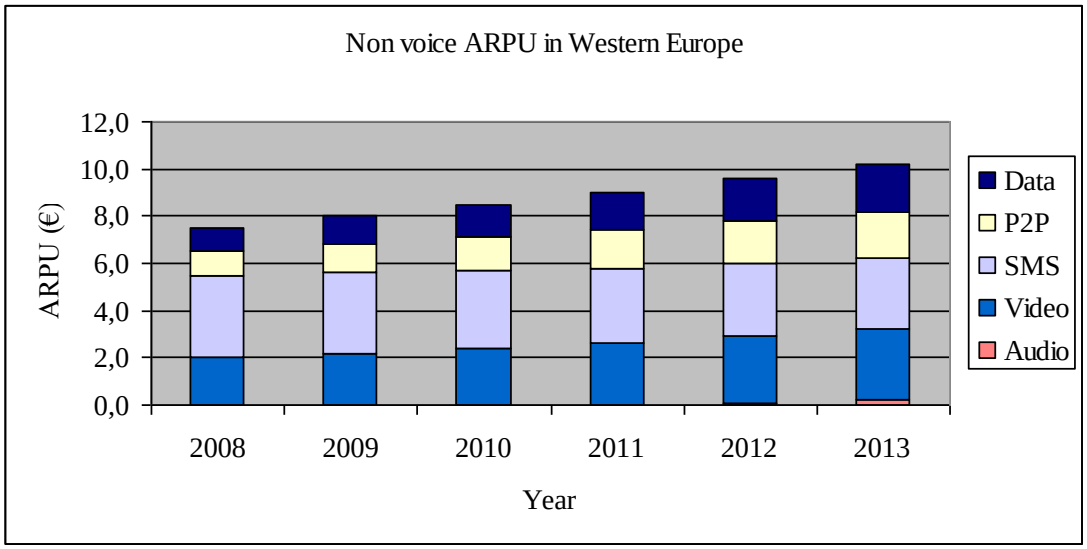

Figure 2. Non-voice ARPU development (Analysys 2007).

However, there are already signs on the horizon that the future of the mobile operators will not be as good as previous Figures 1 and 2 might show. One of the best indicators of the business situation is the total ARPU trend. Although the number of subscribers is still growing and the mobile data ARPU is linearly growing, the price erosion and the competition between the operators and the internet players have severely damaged the voice income per subscriber. A typical mobile operator ARPU behavior from the Western Europe market can be seen in Figure 3 (TeliaSonera 2009).

The total ARPU between the years 2002 and 2008 is shown in the reported numbers, but the weights of voice, SMS and data are estimated based on the information shown in the Figure 2. The total ARPU between the years 2009 and 2012 is extrapolated on the assumption that the ARPU reductions will follow the latest trend. The main message is clear. The voice ARPU is linearly decreasing and in parallel to this, the data ARPU cannot fully compensate the voice revenue losses. The SMS ARPU has already become saturated, but it still brings stable income for the whole portfolio. However, one reservation about the conclusions has to be made. Subscribers often have several SIM-cards, but unfortunately the ARPU measure does not take this fact into account.

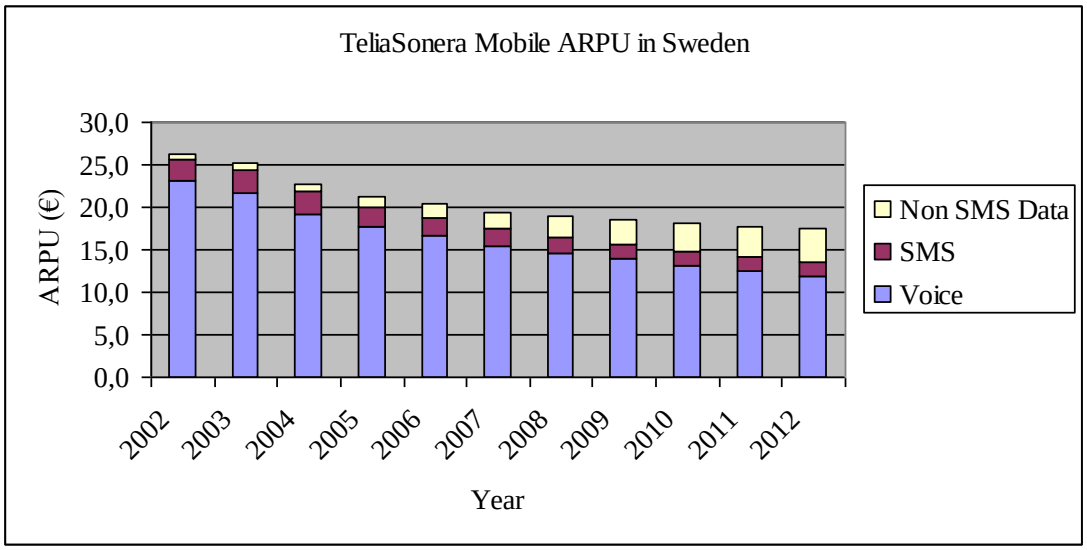

Figure 3. TeliaSonera mobile ARPU trend (TeliaSonera 2009).

Mobile operators still have a strong position among their subscribers, and operators have a lot of unused opportunities. Jong Lok Yoon, CTO of Korean Telecom, noted that operators need to transform themselves into more customer-centric and highly innovative companies, and restore their role as true market leaders (Yoon 2007). Similar comments were highlighted by Vodafone CEO Arun Sarin in the 3GSM 2008 opening speech, where he said that operators must both partner and compete with the internet companies. At the same time Sarin pointed out that operators must ensure that operators are relevant for their customers (Lomas 2008).

Which strategies do mobile operators have available in this situation? The first option is to improve the operating expenditure to ARPU relation. Even with a low ARPU, operators can run a successful business if the operability costs are under control. This alternative suits the so-called bit pipe providers, who voluntarily ignore the service domain and just concentrate on the transport and the basic voice and text messaging services. However, in the later phases, this strategy may lead to difficulties. Operators do not have any control points, and this fact exposes operators to the customer churn. Also new transport technologies, such as LTE (Long Term Evolution) and Wimax, are emerging making the price per bit competition more and more challenging.

Operators have both existing and unused assets. The most important is the close customer relationship. Mobile subscribers do not change the mobile service provider as easily as they can change their search engine, although the customer churn is a challenge for mobile operators, too. Secondly, operators have an excellent voice and text messaging machinery that has paid for itself a long time ago. Operators have a lot of unused assets, too. Operators can, for instance, utilize their trusted reputation for 3rd party payments and identity management. Additionally, mobile databases contain large amounts of detailed subscriber profile data, such as location, call, messaging and browsing history. That information can be utilized to directly benefit the end users as new personal services, or to indirectly create new revenue sources from the content providers and the advertisers. In this connection, O'Reilly (2007),

who is one of the inventors of the term Web 2.0, asked in his blog why operators do not open their assets for the developers.

There are several areas where operators can learn from internet technologies, innovation methods, service types, organization structures, business strategies and especially novel business models. The financial background does not prevent new innovations. The main obstacle is the old mindset that has its basis in the past success. However, changes are required immediately. Otherwise the operators will follow the path of their infrastructure providers. Manufacturers have already realized that the role of a bit pipe manufacturer will not bring long term profits, but that they will have to provide various services for their operator customers. Correspondingly, mobile operators must step outside of their comfort zone. In this respect they must offer their end customers value added services and utilize new business models.

1.2. Research scope

Shapiro & Varian (1999) discuss the optimum between openness and control. Companies should optimize the value of their technology and not the control over it. The reward is defined by multiplying the total industry value by the company's share of it. Openness will create a bigger market, while the proprietary approach will shrink the market size. The optimum strategy can be found by maximizing company's reward. The trade-off between open and proprietary alternatives is a fundamental issue in the networked markets. The optimum solution can be found from between these two extremes (Luukkainen 2008). See Figure 4.

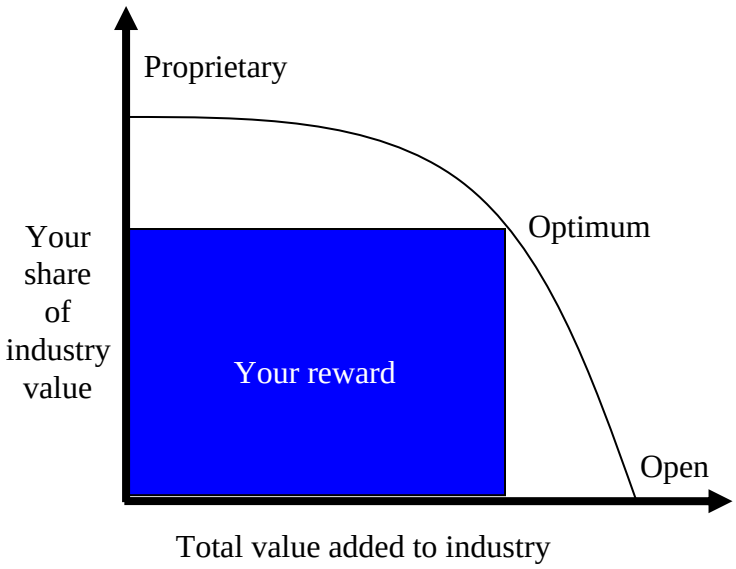

Figure 4. Openness vs. control (Shapiro & Varian 1999, p. 198).

Because the information technology consists of systems having components from various players, companies are forced to share their knowledge between others to maximize the total system value. However, Shapiro & Varian (1999) stress that openness requires a more cautious strategy than control. This openness means

different things for different parties. Alliances can be useful to promote openness. Sometimes, however, a neutral player is required to settle the conflicts.

Mobile services have been technology driven and strictly controlled. Operators have decided who can create services on their networks and on which terms. This closed model has been also called the walled garden. For the end users the closed model offers both positive and negative impacts. The end user experience is consistent, but on the other hand, a service selection is limited to the operator portal. The access to the external portals can be allowed, but the price discrimination often violates the principle of network neutrality. At the other extreme, operators can partly or fully omit the service domain. This approach is called the open model. End users have a full access to any service provider content. Operators just provide a bit pipe that is often charged on a flat rate basis. The variation of services is large, but on the other hand, the service quality can vary and security challenges may exist. For the operator the open model does not provide a good incentive due to the flat rate charging system.

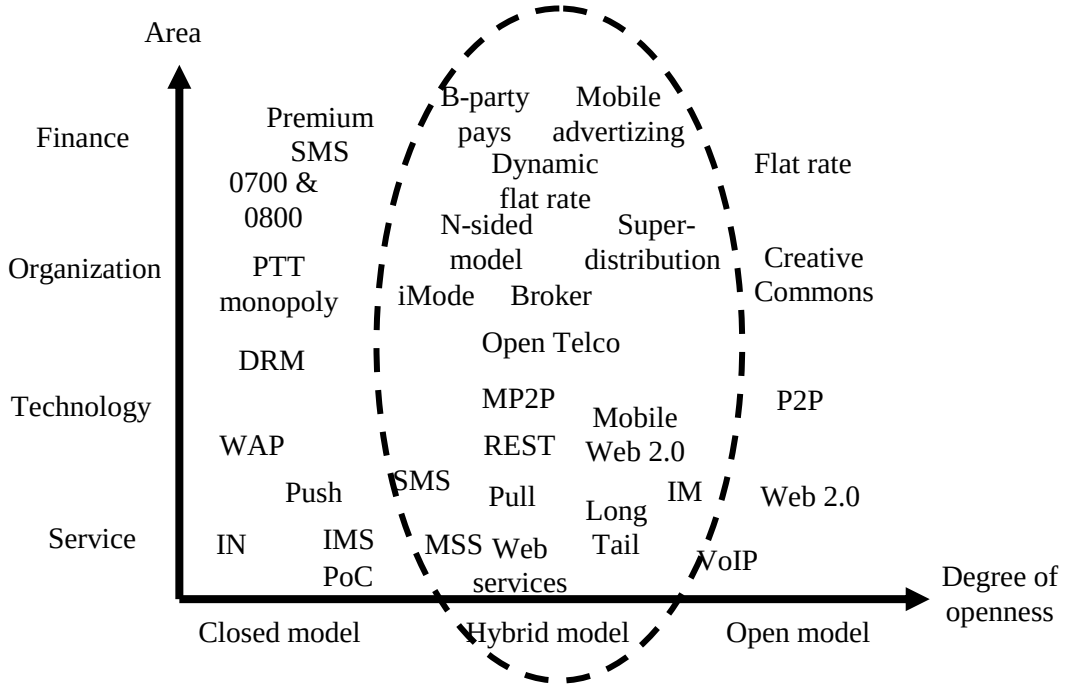

Figure 5. Different operator models.

Instead of the extremes, operators can select a hybrid model. NTT DoCoMo's iMode-service was one of the first examples where the operator applied experiences both from the walled and open models. The iMode-service released the service provider control offering both operator and external services that shared the common operator billing system (eds Bouwman, De Vos & Haaker 2008). The hybrid model combines the best parts from the closed and open models. This study elaborates the hybrid model with emerging business models that strengthen the mobile service industry. Figure 5 shows examples of how service, technology, organization and finance initiatives map to different mobile models (eds Bouwman, De Vos & Haaker 2008). The mapping is illustrative and based on the results presented in this thesis.

The scope is restricted to the mobile services, where the mobile application is carried to the end users through the mobile handsets. By this definition, for example, services offered to the mobile operators are excluded from this study. The fixed networks, including also cable networks, are not part of the study, but some results can be applied to them, too. The research results are applicable to any mobile data markets, but especially with focus on the developed countries. In developing markets mobile penetration is still low, and on the other hand, the main mobile services will be voice calls and text messages for a long time ahead.

However, there are also certain limitations in the scope of the research. The telecommunication sector is strictly regulated, leaving operators less opportunities for radical innovations. Operators must ensure life critical phone and mobile connections, even during a crisis. They must also strictly obey the regulations on privacy, phone secrecy, lawful interception and charging data, requirements which place a heavy burden on operators. Besides, customers are divided between several, competing operators. This fact complicates the introduction of nation wide social and advertising services.

1.3. Research approach and methods

The chosen research approach is mainly based on the services, technology, organization, and finance (STOF) model created by eds Bouwman, De Vos & Haaker (2008). Services Sciences (Hefley & Murphy 2008) is a similar concept involving the following factors: services, technology, business design and innovation. The differences between these models are not big. STOF includes the innovation part inside the services as a service innovation, and additionally STOF highlights the importance of the service execution under the label organization. Single companies cannot manage all service requirements alone but co-operation is required, even between the competitors. The whole regulation field, including standardization and patent policies, has always held a great importance for the mobile industry. In this study most of those subjects were neglected due to the chosen focus. Behavioral, psychological and social factors also have a great impact on the success of new services, but those topics were beyond the scope of the analysis. The final research approach with references to attached publications is illustrated in Figure 6.

The main research method in this study is the literature review, including books, conference papers, periodicals and analyst reports. A lot of feedback has also been gathered directly from mobile operators, infrastructure manufacturers and academic institutions, through face-to-face discussions and conference meetings. Based on these experiences, a set of conference papers was written and published. These articles have highlighted dedicated areas where the common nominator has been the fusion of the internet and the mobile service domains. The complete research work would require simulations, experimental trials and formal interviews with the ecosystem participants, including end users, developers, operators, content providers and manufacturers. Due to the limited scope of this licentiate thesis, those steps were left for the next, doctoral research phase.

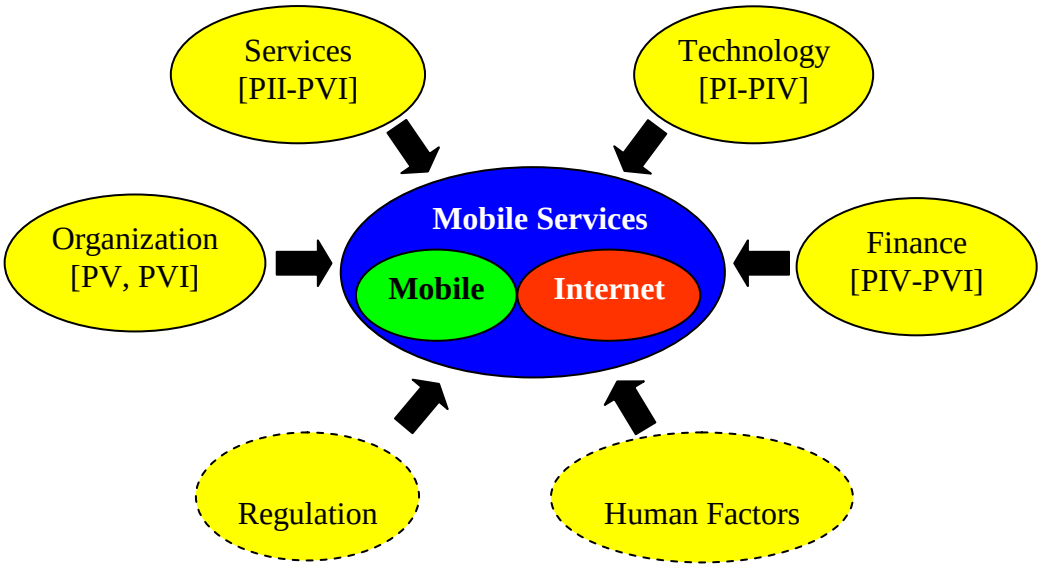

Figure 6. Research approach.

1.4. Research questions

The main research question follows whether the hybrid model is the optimal solution for mobile operators to compensate for the ARPU decline. According to the research approach, new business model innovations have been gathered from service, technology, organization and finance areas. The Internet is a common nominator for most innovations. The starting point in the research is the underlying signaling system. The critical question is whether the IP Multimedia Subsystem (IMS) can fulfill its promises as a generic service center in 3G mobile networks (Poikselkä & Mayer, 2009). The other alternative is based on the evolution of the existing 2G Mobile services Switching Centres (MSC).

The second critical question relates to the internet technologies. Web 2.0 technologies, such as Ajax (Asynchronous communication, Java, and XML), RSS (Really Simple Syndication) and widgets, have emerged on the Internet, but whether they are feasible as such in the mobile internet, is an open question (Jaokar & Fish 2006). In the Internet peer-to-peer (P2P) networks have been widely popular in content distribution and sharing. A natural idea would be to utilize the P2P networks also in the mobile networks. However, there are several technological (Heikkinen & Luukkainen 2008) and business (Kwok, Lang & Tam 2002) choices available. Copyright and digital rights management (DRM) are controversial topics. Several researchers (Stallman 1993; Fisher 2004; Lessig 2005) have criticized the copyright laws. They claim that copyright actually restricts the rights of artists. The mobile domain has its own challenges and opportunities (OMA 2006).

Mobile operators have one major challenge in the service competition with the internet rivals. That is the lack of global reach. Social services require accessibility over country and operator borders. With regard to voice and text messaging services, operators have solved the problem by national and international roaming agreements, but other mobile services are still lacking a solution. One way is to voluntarily hand

over the services space to the internet providers and concentrate on the enablers, open APIs (Quayle 2008). According to Shuen (2008) the internet picture service Flickr declared already in 2004 ‘Don´t build applications. Build contexts for interaction’. Anyhow, a bridge between the mobile and internet domains is clearly required (Loreto et al. 2009).

As a summary, the main research question follows:

Is the hybrid model the optimal solution for mobile operators to compensate for the total ARPU decline?

The sub questions and references to publications are listed in the Table 1.

Table 1. Sub-research questions.

	Sub-research questions	References to publications
1	MSS or IMS, what is the best option to organize the mobile service core?	PI
2	Is it possible to reuse the internet technologies as such in mobile services?	PII, PIII
3	How should the copyright laws be applied to mobile services?	PIII, PIV
4	What are the best mobile service revenue models?	PIII, PIV, PV, PVI
5	Do operators need a broker to provide multi-operator services?	PV
6	What are the operator assets for the developers?	PV, PVI

1.5. Research results

The research results and answers to the research questions have been described in six publications. All publications, except the first one, have been published during the course of the research period, e.g. between the years 2006 and 2009. Publication I elaborates the cellular network transport architecture evolution from the circuit to the packet switched networks. The Mobile Switching Centre Server (MSS) concept is described with a comparison to the IP Multimedia Subsystem (IMS). Publication II and III review how do the internet technologies fit to the mobile systems. In Publication II the pull and push approaches are compared between each other. In the mobile networks messages are usually transmitted utilizing the push method, but in the Internet the pull is more common alternative. Publication III proposes a mobile peer-to-peer (MP2P) architecture that has predecessors in the internet peer-to-peer (P2P) architectures. The new idea is to add a mobile mirror page to the network to save unnecessary, over the air, mobile data transfers. In any case, the internet protocols often require adaptations for the wireless environment.

The copyright laws are controversial. The strict copyright control can harm innovative revenue models. Publications III and IV present novel methods to replace

the control with openness. The MP2P architecture described in Publication III enables viral marketing opportunities that are invisible in the current P2P networks. In addition, the paper proposes a new concept, called *right of usufruct* that can be applied to mobile content. Right of usufruct means that content is always owned by the content provider, but the end user has the right to consume content. The same idea has been utilized in the new Spotify music service. Additionally, Publication III describes an idea of dynamic, promotional data plans. Publication IV suggests new ways of facilitating the digital rights management (DRM) technologies on the mobile environment. The main idea is to use DRM more for content tracing than content protection. Content tracing enables new revenue models such as viral marketing. New revenue models can be found also from various internet music services.

Mobile operators have difficulties to compete with the internet competitors. The agile internet players are free to offer their services across the national and global borders. Mobile operators are lacking this benefit. Publication V presents a broker architecture, that helps operators to share and combine resources with their partners and competitors. The architecture provides application developers with a similar ecosystem that they have been using in the Internet. Publication VI promotes new operator assets. Open mobile infrastructure APIs, such as location, call, messaging, presence, profile and payment APIs offer totally new opportunities to application developers to harness the user generated content (UGC) and the Long Tail (Anderson 2006). With these initiatives mobile operators can successfully challenge the internet players.

1.6. Contents of the thesis

The format of the thesis is based on the article dissertation, with a summary preface followed by the original publications. The preface includes four chapters: introduction, literature review, results and conclusions. References and results are structured according to the research approach described in the earlier chapter. Chapter one provides the introduction to the whole research work. It describes the research background, approach, methods, questions and results. Chapter two introduces the main literature references. In the literature review the main emphasis has been on the novel, Internet related references. The research results are presented in chapter three. It includes the main themes collected from the publications and related research results, such as public patents. The last chapter includes a summary with a list of recommendations and suggestions for future study items. The original publications follow at the end as attachments.

2. Literature review

The literature review is based on the research approach shown in Figure 6. The relevant literature references and results are presented under the same themes as illustrated in the approach. In the beginning the STOF model is briefly described. According to the model, the analysis of the literature is started with services and innovations, followed by technologies, and leading towards organization and finance questions. The focus is on the mobile and internet service fusion, highlighting the topics that enable new emerging business models for mobile services. The literature references consist of books, conference and journal papers, analyst reports, web blogs and articles.

2.1. STOF

The STOF model (Service, Technology, Organization, and Finance) offers a systematic approach for describing and designing business models. The model is developed by Bouwman, De Vos & Haaker. The framework emphasizes a holistic view of the business models that consist of four interrelated domains: Service, Technology, Organization, and Finance. The goal is create value for both the end users and developers. See Figure 7. The STOF model suits for any digital services but mobile services are the primary targets. For the real business model design, the STOF framework includes a STOF method. It includes a step-wise guideline to designing the business model outline.

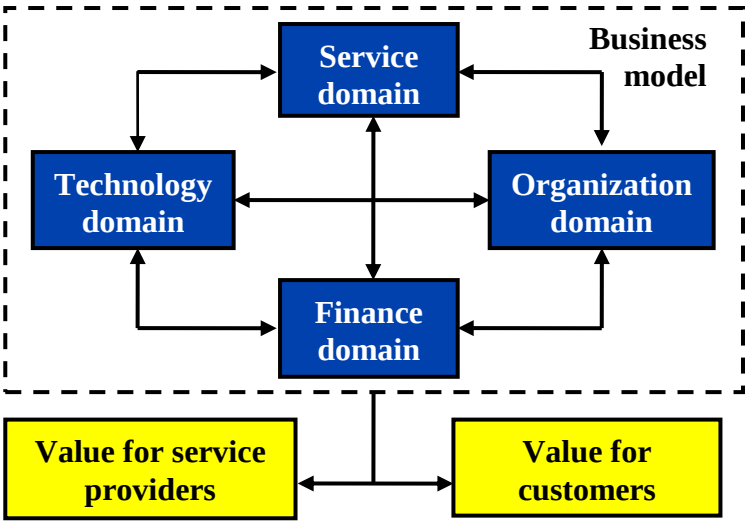

Figure 7. STOF model (eds Bouwman, De Vos & Haaker 2008, p. 36).

The starting point of the analysis is the Service domain. It defines what the value of the service is. Additionally, the Service function evaluates customer segmentation, pricing, the ease of use, the context of use and the bundling of services. The Technology domain defines the technical architecture including access and backbone networks, service platforms, devices and applications. The Organization domain

analyzes the value network that is required to implement the service. The value network consists of actors that have strategies and goals, resources and capabilities, and interactions. Furthermore, these actors perform value activities that place requirements on the technical architecture and generate investments and costs, and finally deliver value. The last domain, the Finance domain gathers costs from the value activities and the architecture, while revenues are collected from delivered value in the target segment. Adding investments, sources and risks finally gives the correct pricing. (eds Bouwman, De Vos & Haaker 2008)

The four domains have close links to each other, highlighting the dynamic nature of the model. The STOF method is a useful tool to design a business model outline. The method consists of four steps: basic questions, critical success factors (CSF), critical design issues (CDI), and internal and external issues. Based on these basic questions a quick scan can be made. The output is the business model outline. The CSFs provide eight factors that are used to evaluate the outline created by the quick scan. In the third step the CDIs are written. The output is the business model design. In the final step the design is reviewed using internal and external issues, ensuring a robustness check. The final output gives the viable and feasible business model design. (eds Bouwman, De Vos & Haaker 2008)

2.2. Service

2.2.1. Definition

Products cover both goods and services. Traditionally, services differ from physical goods, by stressing the intangible nature of services. A service has various definitions depending on the author and background. The definitions 'All economic activity whose output is not physical product or construction' (Quinn, Baruch & Paquette 1987) and 'A service is a provider/client interaction that creates and captures value' (IBM Research 2009) are compact ones. A more detailed definition follows like this:

> A process consisting of a series of more or less tangible activities that normally, but not necessarily, take place in interactions between the customer and service employees and/or physical resources or goods systems of the service provider, which are provided as solutions to customer problems. (Grönroos 2007, p. 52)

These definitions are adequate in this context. Furthermore, customers more or less participate in the service creation process. Because services require a considerable amount of human activity, they rarely adhere to a predefined process. Services are perceived as the output of a process as well as a process itself. As a summary, products contain parts from both goods and services (eds Bouwman, De Vos & Haaker 2008). According to Zeithaml & Bitner (1996) services can be identified according to five characteristics: intangibility, inseparability, perishability, heterogeneity, and ownership. Services are intangible, they cannot be touched. Secondly, services are produced and consumed at the same time. Thirdly, services are perishable, they cannot be stored. Fourthly, services have a heterogeneous nature,

meaning that they change all the time. Finally, services cannot be owned, but usually a consumer has just a usufruct, or a right to use the service for a certain time.

IBM Research proposes that service interventions include three service players: a provider, a client and a mediator (IBM Research 2009). This setup underlines that a service provider and a client can have a direct relationship but in some cases a mediator is a useful function between the provider and the client. See Figure 8. Services science has a place on the research agenda. Up to half of the service events do not meet service client's or provider's expectations (Hefley & Murphy 2008).

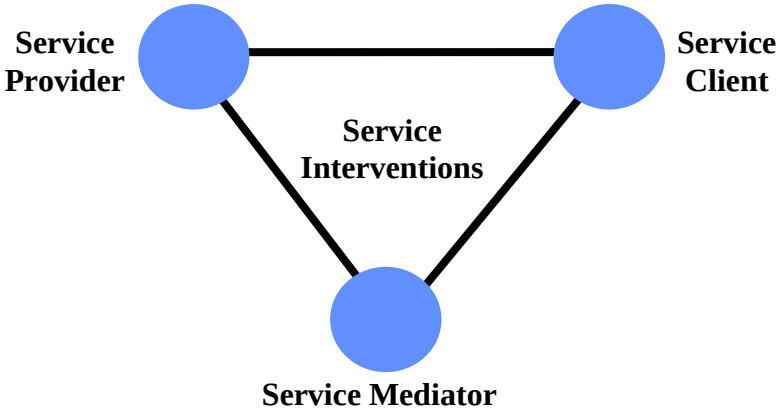

Figure 8. Service interventions (IBM Research 2009).

2.2.2. Vision

Every company requires a core strategic vision (CSV) in order to get a destination, and a roadmap forward from the current position (McGrath 2001). Without a correct vision and strategies implementing it, innovation becomes very difficult. There are several reasons why companies can have a wrong vision. A strong current position leaves the company exposed to tunnel vision, blindness and short-sightedness. These kinds of weaknesses are typical for incumbent companies which do not have any immediate threats, and a long successful history behind them. Hallucination is the fourth trap. Enterprises see opportunities and create products for markets that do not exist or materialize a lot later.

Predicting the future is difficult but there are methods to improve accuracy in innovations. According to Christensen (2004) the process of predicting the industry change starts by reviewing the signals of change. The signals of change include three customer groups: non-consumers, undershot consumers and overshot consumers. The first group includes customers who do not use the current services at all. This group is the most important for predicting radical innovations. The second group, also called the lead users, is often the most used reference group to predict radical innovations. Unfortunately, using this group may lead to false predictions with their specific needs. However, for incremental innovations lead users provide valuable information. The last group, the current mass market, utilizes only a small part of the product features and prefers simpler products. The radical innovation can succeed if the product usability improves.

Schilling (2005) discusses about the difficulties in predicting the customer requirements. The first mover has a few advantages but surprisingly often the follower wins the market. The correct timing of market entry is challenging. The entry barrier is often high, due to customer habits or the competitor patents. Also, the replacement product must offer considerable improvement over the previous solution. Customer requirements are often uncertain, a technology is under developed or new features are unknown for the end users. On the other hand, the customer needs can also be well known. This is the case, for example, with traditional services that have just been modernized with the new technology.

Furthermore, Schilling (2005) highlights the importance of complementing products. Luukkainen (2008) finds that leveraging the demand of the existing customer services helps to adopt the new innovations. Trusting in the success of the previous technology cycles can be misleading. Openness enhances the diffusion of discontinuous technologies. Through experimentation the market selects unexpected dominant designs. Later, due to the variation and competition, a single and global dominant technology is achieved. In standardization options and sharing IPRs on reasonable terms accelerates the acceptance of new innovations. Innovations should be independent of the network infrastructures and service features.

Openness is one way to improve the accuracy and quality of the vision, the innovations and the products. Early warnings or weak signals can be detected. Weak signals are considered to be early indicators or symptoms of information about coming events. They are often minor events that may have major consequences. It is difficult to distinguish the weak signals from the information flow, and this is the reason why they are often missed (Uskali 2009; Nikander 2002). Breidenbrücker (2007) gives simple advice for detecting weak signals: pay attention where you pay attention.

2.2.3. Strategy

A good vision without a good strategy and implementation is worth nothing. The internet strategy requires special attention. Porter created the Five-Force Model in 1980. He later applied the theory to the Internet, too (Porter 2001). The paper highlights the fact that the Internet is a complementary delivery channel that can effectively support existing trading methods. In this respect, the Internet should not be seen as part of a new economy because the old business laws are valid in this case, too. The Internet does not inevitably guarantee economies of scale, but success depends on the strategy. The Five-Force Model is as valid for internet business as for any traditional trading.

The bargaining power of the channels is getting weaker, but in general, from an enterprise's point of view, most of the forces are negative. The Internet offers consumers new methods to compare prices over wider geographic areas and to select the cheapest ones. In this respect, the nation-wide regulation rules do not support internet trading very well. The threat of substitutes is evident, at least if the price is much cheaper. E-commerce empowers the competition. Prices are getting lower and similar. The dominant market position gives a competitive edge making entry for newcomers extremely difficult. Competition with existing competitors will get

fiercer, and will make it difficult to differentiate the competitors from each other in the eyes of the consumer. Any good idea can be copied immediately. (Porter 2001)

Management of technological innovation (MTI) provides the strategic framework to manage incremental and radical innovations. Dodgson, Gann & Salter (2008) stress that MTI brings companies an absolute advantage. There are different views on MTI: corporate, national, theoretical and individual perspectives. Innovation strategy can be passive, reactive, active or proactive depending on how well companies are prepared for new innovations. Proactive strategy requires most resources and is also the most complex. Dodgson, Gann & Salter (2008) also claim that open innovation and networks are important. End users must be harnessed for innovation. Trust is a key issue. Moore (2000) argues that companies should concentrate on the core competencies and products. Core products should be insourced while context products can be outsourced.

2.2.4. Innovation

Innovation is surely one of the most popular words in the current leadership vocabulary. According to Schumpeter (1934), innovation was an important accelerator of new technology cycles. He identified five different innovation types: new products, new methods for production, new sources of supply, exploration of new markets, and new ways to organize business. In modern literature innovation can refer, not only to technological, but also to organizational and institutional innovation. These innovation types form the basis of the innovation process, and are conceptualized as systems of innovation (Hekkert et al. 2007). Innovation takes place in complex environments that are characterized by dynamic interactions between institutions and organizations that affect the development of innovation. Technical risks can also endanger the new product. Schilling (2005) classifies innovations to competence enhancing and destroying. According to Chesbrough (2003) innovation is being transformed from a centralized inward-looking, closed approach mainly driven by technical innovation to an open innovation approach. (eds Bouwman, De Vos & Haaker 2008)

2.2.5. Disruptive innovation

Dominant designs and incremental changes converge due to technological discontinuities to an era of ferment (Schilling 2005). Disruptive innovations are typically simple, cheap and revolutionary. According to Christensen (2004), new market entrants can utilize either low-end disruption or new market disruption strategies. The first alternative fulfils the needs of low end-users, gaining a market position. The second one attracts customers who are looking for product features that are not offered by the current incumbents. See Figure 9. On the other hand, the resources, processes, and values (RPV) theory explains why incumbent companies have difficulties in reacting to disruptive innovations. The organizational resources and processes are usually tailored for the current products. Company values prioritize factors, such as customer requirements, cost structure and size of opportunity, giving less emphasis to new innovations. The value chain evolution (VCE) theory assesses whether a company organization structure is optimal for the operations. The core idea

of the VCE theory says that companies should drive the performance along the dimensions that are most valuable for their customers. Radical innovations create a problem for companies because the company organization may be totally unsuitable for new ideas (Christensen 1997).

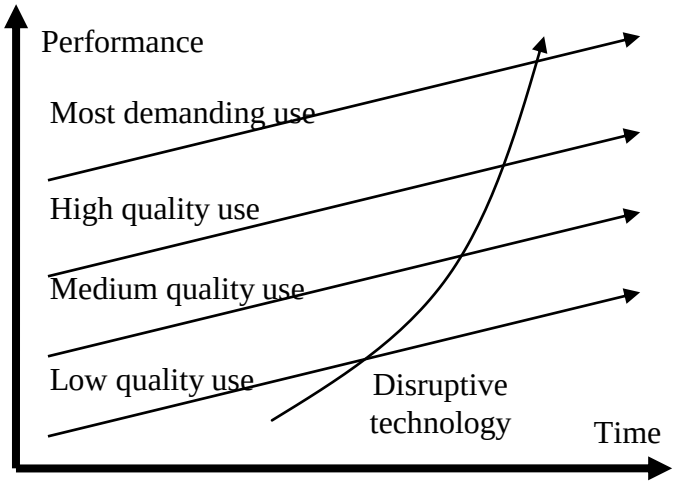

Figure 9. Disruptive technology (Christensen 1997, p. 19).

Mobile operators are afraid of service cannibalization. Popular internet services such as instant messaging, microblogging and VoIP can impact on SMS and circuit switched voice revenues. McGrath (2001) separates cannibalization into two categories: positive and negative. Companies make mistakes because they do not know when they should avoid or accept cannibalization. Cannibalization can be harmful, especially for the market leader, if the new product brings less profit or incorporates unfavorable economics. But cannibalization can also be positive. For a challenger operator a radical innovation with an advanced technology offers an opportunity to attack the incumbent. Also the market leader can utilize cannibalization. They can use the pricing tool and frequently update their platforms or specific product segments. The main risk for cannibalization is the timing. For the correct decision, companies must utilize an analytical framework with a sensitivity analysis to determine the critical break-even points.

2.2.6. Open innovation

According to Chesbrough (2003), 'Not all the smart people work for us. We need to work with smart people inside and outside our company.' This is the key principle for open innovation, illustrated in Figure 10. It can be applied to the mobile industry as well. Gaynor (2003) confirms that the network operators do not have the breadth of knowledge to innovate in various customer segments. Grodal (2004) warns that in the longer term closed networks will reduce innovativeness. Open innovation also promotes more free exchange of Intellectual Property Rights (IPR). If the optimum of internal and external ideas can be found, a win-win situation can be established. Open innovation, however, is challenged on basis that it endangers the first market position, but according to Chesbrough (2003) a better business model is more important. Also seconding the first market entrance usually brings better products. Openness makes it easier to test new ideas. According to Thomke (2003) and Gaynor

(2003) the best way to develop new services happens through experimentation, by successive approximations. For example, a successful Flickr service was invented by accident. Originally the picture storage service was just a support functionality for a social network service, but eventually the auxiliary service became the main one. The same finding concerns the mobile text messaging service. At the start nobody knew that sending 160 characters over cellular would become a successful service. These examples underline the fact that the success of new innovations is difficult to predict. Often a better strategy is to try and fail fast than use long term planning.

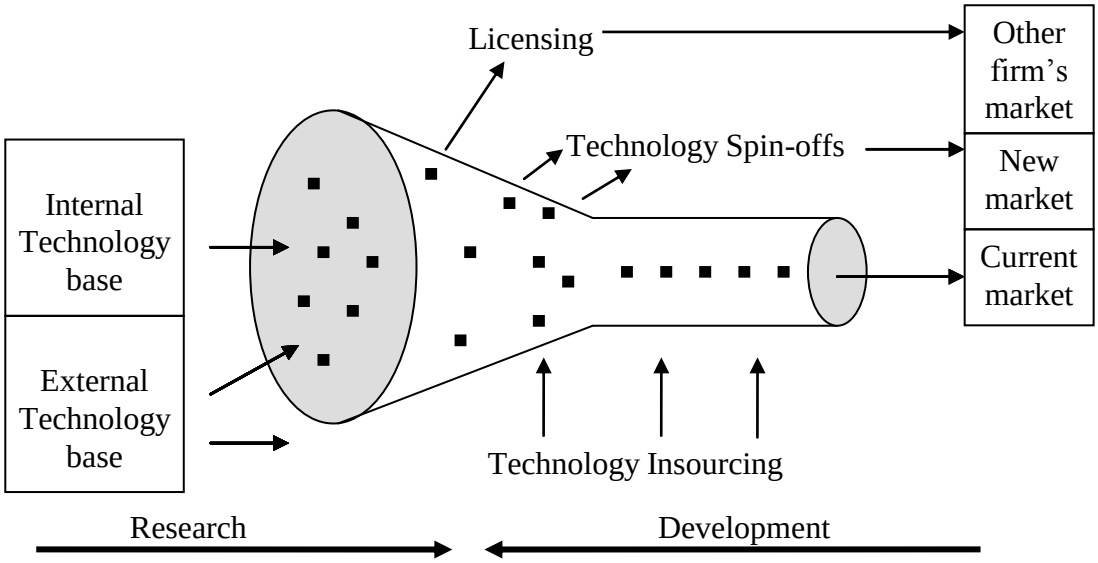

Figure 10. Open innovation (Chesbrough 2003).

Jaokar & Fish (2006) highlight the fact that the definition of openness is not always clear. For example, AOL and Microsoft utilize open standards such as RSS and SIP, although these companies in several cases act for the walled garden. The walled garden approach can be identified from a restricted access. These restrictions can be commercial or technical. Jaokar & Fish (2006) promote an open model called OpenGardens. It provides developer API enablers, a bazaar model to create mashups. They do not believe that the walled garden approach will stand the test of time in the mobile industry. Krechmer (2008) suggests that openness should also be applied to standardization process. He lists ten requirements, that, for example, propose open IPRs, documents and interfaces.

2.2.7. Mashups

The Web 2.0 offers services with mashups. According to Zang, Rosson & Nasser (2008) most major internet web services have opened their resources through public APIs. As a result, web developers have begun to develop software applications that merge separate APIs and data sources into one integrated interface, called a mashup. By definition, anyone can create a mashup. Mashups are not anymore only dedicated for the fixed internet, but they can be applied to mobile services as well. For example, Apple (n.d.) and Google (n.d.) have launched new initiatives to promote mashups for the mobile space. Also the mobile operators can compete in the mashup space. O'Reilly (2007) argued that mobile operators should offer end users' history

data through open APIs. So far, operators have preferred a quite opposite strategy: the walled garden. Lately, the situation has slowly changed. Most operators are trialing with open APIs. Also, the mobile operators' umbrella organization, the GSM Association (GSMA) started a standardization activity to harmonize the open APIs (GSMA 2009). Mulligan (2008) highlights that there is clear link between open APIs and developers. Open APIs must be developed to accelerate innovative service creation. Sánchez & Rodríguez (2008) underline the importance of user centered innovation and social trends that are coming into the mobile networks, bringing the end users into a controlling position as content providers.

2.2.8. The Long Tail

Customer segmentation is a traditional tool for product manufacturers. For service providers a similar tool can be proposed. Several natural phenomena follow the so called Zipf function or the Power law. In the simplest form it means that the quantity is inversely relational to the rank of the item. For example, if words are counted from an English text, it can be identified that the word 'the' is twice as frequent as the second one, three times more frequent than the third word and so on. Also on the internet, the Power law seems to be the rule rather than an exception (Nielsen 1997; Adamic & Huberman 2002).

Anderson (2006) invented to apply the long tail phenomenon to the online services. He found that the wider selection lengthens and fattens the tail. Additionally, the long tail drives the consumption of certain products and services from hits into niches, by bringing previously unknown products and services to public knowledge. Mutanen (2005) calls this type of market, the invisible tail. For example, a typical large music store can hold up to 25 000 titles for sale, while an online store can offer millions of songs. Jaokar & Fish (2006) applies the long tail also to mobile applications. In that context operators provide the mass market services, such as voice and SMS, while the long tail consists of the niche services, created by the open community. Kilkki (2007) has found that the long tail curve can be drafted even with limited source information.

2.3. Technology

2.3.1. Internet

The Internet Protocol (IP) provides an excellent platform for multiservices (Morrow & Vijayananda 2003). Starting from OSI layer 3, the IP offers an efficient and cost affordable solution for networking. Furthermore, the transport layer utilizing the TCP protocol provides a stable foundation for the applications. However, the internet is based on the best effort service, without guaranteeing a proper Quality of Service (QoS), security and mobility management (MM). Standardization organizations have used a lot of time and resources to develop mobile specific standards to cope with these internet weaknesses. Even full mobile architectures have been designed on top of the IP. The all-IP architecture gained a lot of attention at the beginning of the decade.

2.3.2. VoIP

The Internet also provides a large set of protocols that can be applied to the mobile internet. With regard to messaging and presence applications, two different protocols are available: SIMPLE (Session Initiation Protocol for Instant Messaging and Presence Leveraging Extensions) and XMPP (Extensible Messaging and Presence Protocol) SIMPLE originates from the SIP (Session Initiation Protocol), which was originally designed to setup media sessions, including voice over IP (VoIP) applications. SIMPLE is an extension of the original purpose of covering messaging and presence services. XML (Extensible Markup Language) is utilized for presence data transfer. SIMPLE faces challenges in interoperability due to various options and a number of specifications (IETF SIMPLE Charter n.d.).

XMPP is based on the Jabber protocol that originates from 2000. Jabber was designed from day one for transferring messaging and presence data. It is an open, XML based protocol that has been extended in the direction of VoIP direction. XMPP has strengths on decentralization, flexibility and openness, but on the other hand, XMPP has a high overhead and is inefficient due to the XML base (IETF XMPP Charter n.d.). The wide popularity of XMPP in the fixed networks will create interworking challenges with the mobile networks. The specification work to solve these challenges has already been started (Saint-Andre, Houri & Hildebrand 2008).

2.3.3. IN and IMS

The technology cornerstone of the mobile community has been the SS7 signaling system. It provides narrowband signaling services for the GSM system, and also broadband and IP versions for 3G and LTE networks. Protocols on top of the SS7 signaling stack offer application related services. The Intelligent Network (IN) concept was designed to implement the services that are implemented by operators and their partners. IN is at its best when similar services are created for mass markets. Good IN service examples are personal answering machines, the 0700 service and free 0800 numbers. Unfortunately, the IN methods do not suit individual developers due to complicated and old fashion development tools and protocols.

It was realized that IN does not answer the service creation challenges that the Internet will place on the new mobile networks. The mobile industry decided to base the new mobile service economy on SIP. Basically SIP suits both voice and service domains. Additionally, it has a lot of extensions enabling future improvements. SIP is the basic VoIP protocol for the IP Multimedia Subsystem (IMS) that is the core of the service creation in the 3G and LTE systems (Poikselkä & Mayer 2009). The standardization of the IMS was started in 2000 in 3GPP, IETF and various industry forums. The standardization work is still continuing and the large scale live deployments are still missing.

2.3.4. SOA and web services

Service creation technologies are developing with fast speed. The old, centralized IN tools are replaced with service-oriented architecture (SOA) based approaches. SOA

is a conceptual framework that can incorporate a various set of standards, tools and protocols. SOA decentralizes services into loosely coupled, individual units that developers can utilize through well defined APIs. The SOA implementation requires a set of standards, called web services. XML provides a meta data language that defines the service characteristics and the applied data types. In addition, web services include a set of standards for various purposes: WSDL (Web Services Description Language) for service descriptions, SOAP (Simple Object Access Protocol) for messages, and UDDI (Universal Description, Discovery, and Integration) for directories. (Newcomer 2002)

Although SOA and web services contain a full portfolio for service creation, two major problems exist. SOAP performance over wireless links is not optimal (Kangasharju, Tarkoma & Raatikainen 2003) and on the other hand, the web services methodology is still too complicate for many individual developers. The latest trend on the service creation leans on REST (Representational State Transfer), invented by Fielding (2000). REST has received wide acceptance from the developer community (Mäkeläinen & Alakoski 2008). The reasons are clear. REST includes only four methods: get, put, post and delete. It is not tied to any programming language or transport protocol, although HTTP is a natural choice for the transport protocol. Usually, most open API projects support both Web Services and REST principles leaving developers free hands for their implementations.

2.3.5. Web 2.0

Web 2.0 was invented by O'Reilly (2005). Web 2.0 is a loose paradigm promoting seven ideas: web as a platform, harnessing collective intelligence, data is the next Intel inside, end of software release cycle, lightweight programming models, software above a single device and rich user experience. Web 2.0 can be regarded as lightweight version of SOA, but Web 2.0 highlights the features such as web as a platform, community involvement and simple software tools. Really Simple Syndication (RSS) and Asynchronous communication, Java and XML (Ajax) are a few key technologies behind the Web 2.0 software technologies.

Relating to the mobile domain, Mobile Web 2.0 is an extension for the Web 2.0 cloud. Mobile Web 2.0 adds new dimensions for the Web 2.0 principles. According to Jaokar & Fish (2006), Mobile Web 2.0 also includes seven factors: mobile content, I am a tag, multilingual mobile access, digital convergence, Ajax/widgets, mobile search and location. Due to mobile restrictions, mobile content must be adjusted for small screens. In addition, tagging helps to differentiate essential data from less important, and widgets offer compact and lightweight web applications. Besides, mobile search and location information facilitate finding correct data just on time. Digital convergence underlines the fact that mobile is rarely end user's only input device, but it complements the other access methods. The smooth interoperability between different access devices must be ensured.

2.3.6. Pull vs. push

Mobile networks have the intelligence in the core registers. Home Location Register (HLR) traces mobile location utilizing frequent paging. The internet network has a different design philosophy. The network itself is pretty simple, but the peer nodes can be very sophisticated. The philosophic design difference is huge, and it has impact on all network layers, including the service layer, as well. The mobile networks exploit the push approach, while the Internet prefers the pull method. As an example, mobile text messages are pushed to the mobiles, but the internet email follows the pull mechanism. The strategy of mobile centralization helps to provide better security, but on the other hand, the service innovation is restricted. Additionally, the centralization requires complicate and expensive core network systems. On the Internet the end nodes decide, which parts of information they utilize and trust, with a help of reputation management systems and peer evaluation. On the mobile side, operators evaluate all new services before the launch, but on the Internet, the end users mainly take care of the testing task.

According to Hagel & Brown (2005), the pull model is an essential enabler to innovations on the Long Tail and mashup space. They claim that the pull model suits better for growing uncertainty. The pull model enables creativity in unexpected events, combining local, highly specialized and distributed resources. The push method assumes that people are passive consumers, whose needs can be anticipated, shaped and covered by centralized decision-makers. In the pull model customers are treated as active and networked creators, who transform uncertainty from a problem into an opportunity.

2.3.7. P2P and MP2P

Peer-to-peer (P2P) networks utilize the principle of decentralization of the intelligence into the peer nodes. On the fixed networks P2P applications distribute and share content very efficiently. The same P2P approach can be utilized in the mobile networks, too. However, the benefits on the mobile domain are not as clear as on the internet domain. The wireless last mile changes the picture. The basic principle of P2P presumes that each node, or at least a significant number of so called super-nodes, takes part in content forwarding. On the mobile side this is a difficult requirement, because portables are sometimes out of network, battery charge can be low or at least the uplink bandwidth is very limited. For those reasons, all P2P features cannot be copied as such into the mobiles, but a few of those ideas are worth consideration. Mobile P2P (MP2P) is a concept that is built on top of the P2P ideas (Andersen et al. 2004; Marossy et al. 2004).

2.3.8. Digital rights management

The traditional information security functions, such as confidentiality, integrity, authentication, anti-piracy protection, access control, non-repudiation and availability, must be solved before a content business can be started. Digital rights management (DRM) can solve most of these challenges, except the availability that is threatened by denial of service (DoS) attacks. DRM architecture includes three

components: content, users and rights (Iannella 2001). Content refers to the intellectual property, users can be anybody in the delivery chain, from content creators to final consumers, and rights define the permissions, constrains and obligations between the content and the user. DRM utilizes several technologies to provide the information security services. It is a typical misunderstanding that DRM only equals to encryption of the content. Digital signatures guarantee that content is not forged, and thus also non-repudiation. Digital watermarking and fingerprinting are used to copy control, distribution tracking and usage follow-up (Hartung & Ramme 2000). Idea is that a watermark is added to the content before optional encryption. The watermark is difficult to be detected or forged. In some DRM solutions a separate metadata file is added to the content to define the interactions between the content, the user and the rights.

2.4. Organization

Organization consists of resources and capabilities, which relate to technologies, marketing and finance. These factors are required to deliver service. Usually the organization must be capable to co-operate with other organizations, because services produced solely by a single unit are rare. (eds Bouwman, De Vos & Haaker 2008)

2.4.1. Two-sided platform

Ballon (2009) defines that two-sided network theory describes cases, where two types of customers interact on a platform. The interaction is affected by indirect network externalities locating on the opposite sides of the platform. According to Evans & Schmalensee (2008), many diverse industries are occupied by businesses that operate two-sided platforms. The customers of these businesses have a relationship between each other, and for that reason, a common meeting place is required. Two-sided platforms are common in old, advertising based economies, and they play an important role to minimize the transaction costs between the customers. Furthermore, Evans & Schmalensee define five critical factors for the size of two-sided platforms. The list includes indirect network effects, scale economies, congestion, platform differentiation and multi-homing. Finally, the authors warn that a few cautions must be given for the theory on two-sided platforms. First of all, the industries have been defined with abstract models that might not work in the real life. Secondly, there is a lack of empirical data on two-sided platforms, and thirdly, the theories presented depend very much on the industry area.

Evans & Schmalensee (2008) list four types of multi-sided platforms: matchmakers, audience-makers, transaction based and shared input. Eisenmann (2007) divides platforms into two categories: proprietary and shared. The proprietary system, such as Google, has one single provider that fully controls the technology. In the shared system, multiple companies are developing the common platform. Linux operating system is an example of this approach. According to Bambury (2006), most internet services are disintermediated, because that is the cheapest solution. However, most real-world businesses are intermediated. Bringing real-world products into the Internet will inevitably increase the need for new intermediate layers. This development may be positive to consumers, but it creates challenges for the real-

world profit margins. On mobile industry the idea of a service broker has been recently presented in various papers (Asundi 2008; Loreto et al. 2009).

2.4.2. Value chain and value network

Value chain analysis has become a popular theory to identify, where companies create value on products and services. Originally, value chain analysis was created for processes produced within a single company, but later it has been utilized also for multiple companies or the whole industry. Value chain analysis can be used to describe the whole industry, where processes are independently offered by various companies. This approach helps to analyze the position of a single company in the whole delivery network. (eds Bouwman, De Vos & Haaker 2008)

However, the value chain analysis has also weaknesses. It partly ignores the dependencies between the resources of different companies. To overcome this defect, value network was proposed. Value network does not create value in transforming the objects, but in their mediation. The strength of the value network originates from cooperation and interaction among participating companies. Companies believe that revenues increase and, on the other hand, costs decrease. A customer is the central unit in the system, and companies tailor their services around it. Companies become members of the value network, based on their unique competencies. Value network is not tied to any specific region, but it can be even global. Additionally, the same value network can include companies from different industries. (Peltoniemi 2004)

2.5. Finance

2.5.1. Consumer theory

Consumer theory provides important background information for the business model analysis. Consumer theory belongs to the microeconomics that defines, how consumers' preferences meet their demands. The first phenomenon under study is the demand curve (Shapiro & Varian 1999). In Figure 11 the baseline case shows the status quo, where the revenue is optimized with a certain price. More liberal terms and conditions increase the value of the service to the customer, which enables higher prices. Although copying and sharing increase, the total revenue increases. A sustained business model seeks the optimal solution between these forces.

The substitution effect is another important theory. It defines how well two products substitute each other. For example, voice calls and text messaging can be fully complement products, but TV and communication services do not necessarily substitute each other. Michel (2005) studied whether free music downloading increased the usage of movie tickets, but he could not find any proof for that claim. The network effect cannot either be forgotten when the consumer theory is explored. The network effect is the impact that one user of a good or service has on the value exposed to other people using the same good or service (Porter 2001). The exposure effect has been proposed as an effective method to accelerate viral marketing (Porter 2001). According to the exposure effect end users tend to create a preference for the

products that they are familiar with. Finally, Liebowitz (2005) presented a phenomenon called indirect appropriability. The basic idea behind the term is that the seller of authorized copies might benefit from an increased demand for authorized copies due to the value generated by the unauthorized copies. He claims that in the case of free file-sharing, it appears that the net impact of the network effect and the indirect appropriability can be negative on sellers.

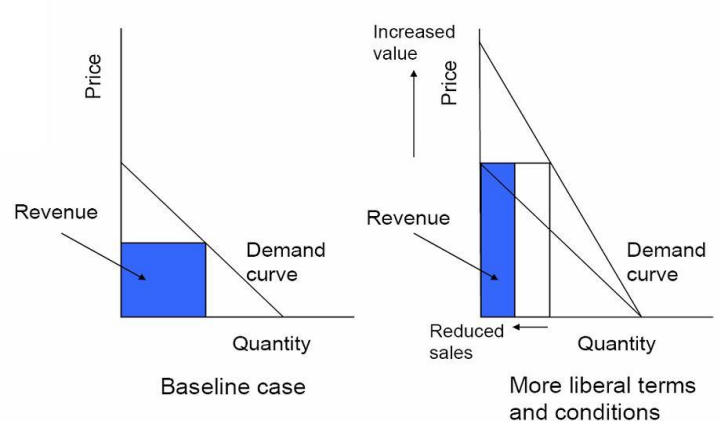

Figure 11. Demand Curve, Quantity and Price (Shapiro & Varian 1999, p. 99).

2.5.2. Mobile

New radio technologies, such as LTE, enable new mobile business models. The price per bit will significantly drop. According to the study by Hoikkanen (2007), LTE includes significant improvements into the radio interface. The advanced radio brings the cost of data down, and enables several, potentially important, new services. If the average data usage is 20 megabytes per month, and doubling every second year, a break even point can be achieved with an ARPU level of 10 euro, whereas a level of 15 euro is already very profitable. Bohlin (2007) confirms this estimate by saying that according to his simulations, a minimum ARPU level of 15 to 19 euro will be required, that the LTE business case will become viable. However, Bohlin warns that a more precise estimate depends on various factors. For example, the average data consumption has a big impact on the results. According to Blennerud (2009), an average data consumption of 2 GB drops the break even point of data ARPU as low as to 2 euro or even less.

From mobile operator's point of view content business is extremely important, because ARPU figures decreasing. There is, however, a contradiction in price per transferred bit between voice and SMS services, and new digital media formats. This is the reason why operators should apply content based pricing schemes to mobile internet (Kivisaari & Luukkainen 2003). Mobile phones are becoming more and more suitable for digital content consumption, and basically mobile phones could replace the standalone multimedia devices. Mobile phones have the advantage that end users want to be always reachable and prefer to carry just a single device (Eylert 2005). A mobile service can facilitate the link between the user experience and the download event, thus stimulating unplanned purchases on the move (Grech & Luukkainen 2005).

2.5.3. Web 2.0

One of the Internet strengths has been the innovativeness on revenue models. The network neutrality principle has enabled various revenue models. According to Shuen (2008), Web 2.0 world has six different revenue models: subscription, advertising, transaction, volume, licensing and sponsorship. Anderson (2009) suggests one additional revenue model: free. Free is very effectively used in conjunction with subscription and advertising business models in various Web 2.0 services. This model can be called freemium (Wilson 2006), combining the words free and premium. Free access is the key to accelerate the positive momentum of the network effect. Parallel discontinuous technological change, ignored by the incumbents, may enable cost effective products that initially attract cost sensitive low-end customers (Christensen 1997). For example, Amazon, Skype, eBay, Yahoo and Apple have been successful to utilize novel revenue models that suit for a new economy.

2.5.4. Free-rider and tragedy of commons

Free business model has also challenges, called the free-rider problem and the tragedy of the commons. The free-rider problem definition says that 'free riders are those who consume more than their fair share of a public resource, or shoulder less than a fair share of the costs of its production' (Cornes 1986). Earlier, it was also estimated that Wikipedia type of community services would fail due to the free-rider problem. However, economists underestimated the human nature that enjoys from the glory that the non-free-riders will earn from the readers (Lee 2008). Horowitz (2006) has found that in successful online services typically one percent of the customers contribute, nine percent comment and the vast majority, ninety percent just read. In a large group, one percent is enough to keep the service active (Anderson 2009). The second free problem, the tragedy of the commons, states that free resources are excessively consumed (Hardin 1968). Economists call this phenomenon uncompensated negative externality (Anderson 2009). In environmental questions the tragedy of commons has led to severe problems, causing, for example, the climate warming problem.

2.5.5. N-sided market

Mobile industry has used to apply one-sided business models to their core call and messaging applications. Subscribers pay the services directly to the operators through prepaid or postpaid fashion. In addition to the core services, operators offer 3rd party value added services for their customers. Even here operators collect the revenues from subscribers, and account part of the income to application developers and content owners. The introduction of mobile Web 2.0 has changed the picture. One-sided business models are complemented with two- or even N-sided markets. Operators can collect revenues also from content providers and developers, and not only from subscribers.

However, operators must provide added value for the ecosystem or otherwise the operator will be bypassed. Iansiti & Levien (2004) define that N-sided markets

connect two or more disparate groups of customers and sellers. In addition, N-sided markets have to attract thousands of users and developers to achieve the critical mass. Dependencies between the different business entities are tight. Iansiti & Levien also note that N-sided markets are more complex to manage than conventional market systems. Finally, Eisenmann (2007) stresses that on the two-sided markets the correct pricing is important. Figure 12 describes how the one-sided markets change towards two-sided markets.

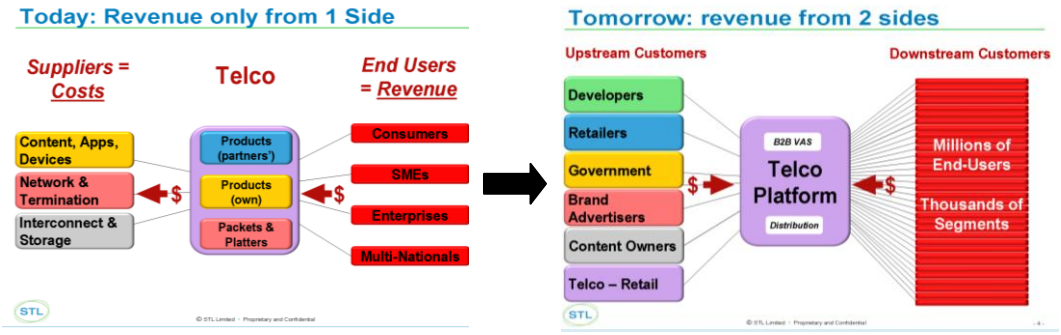

Figure 12. From one- to two-sided markets (STL Partners 2008).

2.5.6. P2P and MP2P

Most of the Internet traffic belongs to the peer-to-peer (P2P) category. P2P applications are mainly outside of the business ecosystem, due to lack of appropriate copyright system. However, also P2P applications can be utilized for business purposes. A proper design of an incentive system is the key for a successful P2P system, underlines Chuang (2004). P2P protocols must provide trust and suitable rewarding. This means that P2P protocols must quantify the incentives and disincentives for cooperation, quantify the impact of free-riding on system performance, encourage direct and indirect reciprocity, leverage peer selection, deal with whitewashers and overcome information asymmetries (Chuang 2004). Kwok, Lang & Tam (2002) propose a three layer P2P business model which depends on the application type. Technology applications must allow user's communication and content exchange, while community applications must enable content sharing and business applications must maximize revenues. Additionally, Kwok, Lang & Tam (2002) stress that P2P business models must explicitly acknowledge and protect ownership rights and control the distribution of digital content.

Ghosemajumder (2002) has studied what are the winning business models for P2P media distribution. He gives three main solutions. First of all, the pricing must be correct. It must be attractive for most customers that they change from a free to a chargeable service. Secondly, Ghosemajumder suggests a commercial exchange standard that would take into account, for example, convenience, ease of use, trust, pricing and personal preferences. He stresses that security is not the correct answer, because it burdens legitimate users. Thirdly, Ghosemajumder claims that free usage cannot be fully avoided. Certain segments of the end users want their content free, whatever is the price. However, he notes that only a small part of the P2P users are willing to share their content, and the major part just want to download music. This

means that only a small number of servers are occupied for file sharing. By feeding false content to the network drops the user experience, driving free users to commercial services.

Mobile P2P (MP2P) has a different nature than P2P on the fixed networks. MP2P exploits the scarce radio resources on the last mile of the connection, requiring both technological and business changes for the basic P2P applications. Besides, mobile devices have several limiting factors. First of all, the battery life and the uplink bandwidth are always limited. Most importantly, mobile owners must pay about the uplink data connection challenging the P2P main principle, mutual sharing. Kumar & Hämmäinen (2005) claim that in mobile networks centralized content delivery would be more beneficial than MP2P. However, the situation will change if personal networks are considered. MP2P can be more economical transport solution if the group size will grow beyond certain limits. Chakravorty et al. (2005) describe a mobile bazaar concept, an open market architecture for collaborative wide-area wireless services. In this concept devices within the bazaar collaborate with each other, and improve the application performance. Financial based incentives and reputation management support this activity.

2.5.7. Copyright

Copyright is one of the fundamental human rights that gives the author of the work an exclusive right for a certain period. The internet services have challenged this basic right (Stallman 1993). Lessig (2005) claims that the strict copyright law prohibits the innovation. For this reason alternative copyright schemes, such as Creative Commons (2009), have been introduced. David (2004) foresees that copyright has reached the end of its life time. Fisher (2004) says that copyright is actually working against the interest of the artists. Yu (2005) notes that the current situation in P2P file sharing is a losing proposition for everyone. He proposes that the industry should work together to develop a constructive, forward-looking solution.

Einhorn & Rosenblatt (2005) have a different view on the digital rights management (DRM). They still believe that P2P and DRM technologies should be left free to evolve together to meet also the future copyright needs. Johnson (2005) advocates creative pricing that would make copyright useless. Bambury (2006) says that the current regulatory frameworks must be changed to encourage innovation. Especially the current U.S privacy policy is backward, he continues. The government places restrictions on the technology development to protect privacy, while simultaneously free market solutions would be preferred.

3. Results

3.1. Service

3.1.1. Open Telco APIs

Location is surely the most common mashup feature that operators have planned to open for developers. However, it is not the only one, and, like Google has demonstrated, mobile operators are not the only actors, who can deploy this asset. Additionally, mobile operators can consider opening their basic network infrastructure APIs, such as call control, messaging, browsing, payment and profile. The presence feature is already familiar from most internet social networks, but on the telecom side, the presence could also relate to the network presence, showing whether an end user is in free, busy, or roaming state. See Table 2 to find a summary of APIs and corresponding service examples.

These APIs can be used alone, or in conjunction with each other, to launching triggers. For example, when an end user enters a certain location area, a call or message, including an advertisement or a predefined service, is sent for the user. This kind of triggers can also enable family, group, and friend services. Call and messaging rerouting may open interesting scenarios, as well. End users, in addition to small and medium enterprises (SME), might define different rules into their call control logic. Besides, machine-to-machine (M2M) type of services could benefit from open call control APIs. Automated meter readers might easily utilize trigger-based call and messaging APIs.

Table 2. Open Telco APIs.

API	Service examples
Call control	Call rerouting & triggering
Messaging	Message rerouting & triggering
Location	Advertising, find friend, timetable
Payment	Micropayment
Network presence	Roaming state, free & busy
Profile	Advertising, recommendations
Service Level Agreements	QoS, security, content caching & delivery

Mobile operators have a number of various databases, which are full of dynamic and static customer history data. Operators and subscribers usually have a steady and long billing relationship, which fact explains, why the operators have accumulated considerable amount of demographics data. These areas provide one basis for the use cases, especially if those assets are connected to advertising markets. Operators also know which kind of phone models their customers are using, and this information helps service developers optimizing their applications into specific mobiles.

Additionally, operators have a long experience on secure micro payment. Telecom bills include tens or hundreds small call and messaging events that must be converted into bills, keeping the raw data in safe storage systems. The same billing engine could be utilized to third-party micro-payment applications. The last category of open APIs relates to Service Level Agreements (SLAs). Mobile operators are experts with Quality of Service (QoS), security, and optimized content delivery that use local caches. In certain applications, these additional features might be interesting from developer's and SME's point of view.

3.1.2. The Long Tail

The Long Tail approach can be applied to mobile industry, too. The main idea is to divide service markets into three segments. The first segment includes operator's own, mass market services. The second one offers the services created by partners. For example, various business services belong to this segment. The last segment consists of the long tail services invented by the open community. These services are typically tailored to niche markets, where the service life cycle can be just a few hours long. See Figure 13. The long tail highlights the fact that also the end users can become service providers. It is notable that the average user does not exist. All end users have different usage habits, with different number of calls, emails, text messages, pictures, music, browsing, social networks, radio and TV channels, contacts, applications etc.

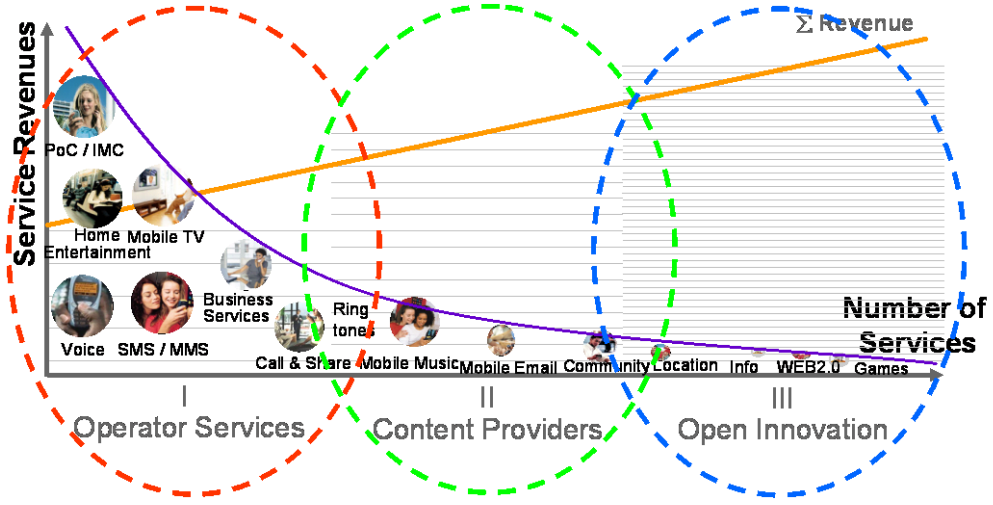

Figure 13. Long Tail of mobile services.

3.2. Technology

3.2.1. MSC Server

Evolution from 2G to 3G mobile systems has created a lot of challenges for operators and infrastructure vendors. The 3G standardization is based on the idea that the same core network can be used both for 2G and 3G networks. Only the radio access network (RAN) and base stations, called node Bs, had to be deployed for new 3G networks. Although the core network mainly remains the same, the interfaces, based on ATM and IP, towards the core network were updated. This meant that Mobile services Switching Centres (MSC) had to be equipped with new interfaces and signaling stacks. Figure 14 shows the circuit switched (CS) interfaces, the 3G IuCS and the GSM A. Similar arrangements were required for the packet switched interfaces, called the 3G IuPS-, the GSM Gb- and the Gn-interfaces. See Publication I for more details.

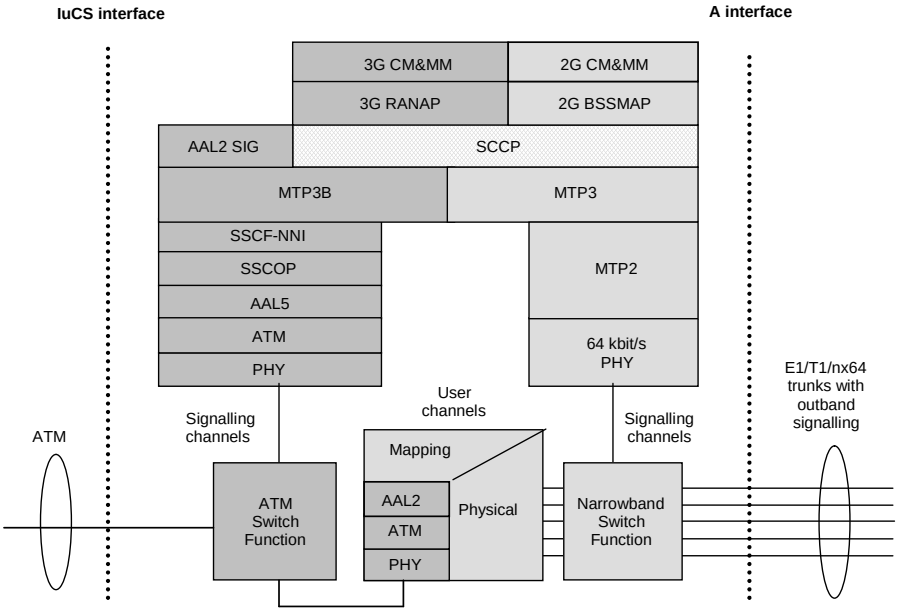

Figure 14. Control and user planes on the CS interfaces.

Operators and vendors had basically two alternatives to upgrading their 2G networks to 3G. Either they deployed new 3G MSCs or provided the existing 2G MSCs with interworking units (IWU). Figure 14 already indicated the challenges with the IWU alternative. The lower narrowband and broadband SS7 stacks are pretty compliant with each other, but on the mobile application layers differences are significant. During the development, a new idea called enhanced 2G MSC, was proposed. It is based on the IWU approach, but it promotes the investment of the existing 2G MSCs.

The main idea of the enhanced 2G MSC is that the IWU will interwork just the user plane. Instead, the 3G signaling stacks are directly implemented into the 2G MSC. This idea makes the IWU much simpler, because the interworking of the user plane can be mainly implemented with the hardware. On the other hand, the 3G signaling

stacks are independent of the user plane, which means that signaling stacks can be implemented in the 2G MSC without any hardware changes. All new ATM hardware is located in the IWU. The enhanced 2G MSC was later named MSC Server (MSS) in the 3GPP standardization. Lately, the same approach has been applied to IP Multimedia Subsystem (IMS), too. In this case, the MSS includes IMS functionality, making the evolution from MSC towards IMS lot easier and cheaper. Figure 15 shows a draft architecture of the enhanced 2G MSC.

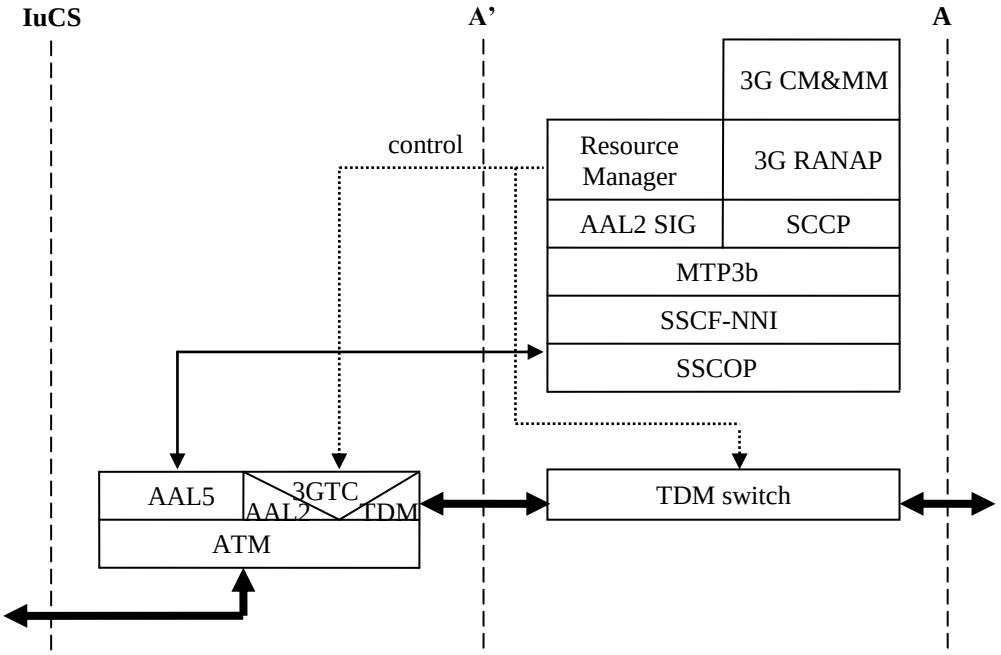

Figure 15. Enhanced 2G MSC.

The enhanced 2G MSC included also another invention relating to the interaction of control and user planes (Raivio, Kekki & Pirkola 1999). One of the main principles of 3G was to separate control and user planes from each other. This was not the case with 2G, where the signaling channels were physically part of the user plane. The separation of control and user planes enables the user plane evolution. At the beginning of the 3G specification work, ATM was the primary candidate for the user plane technology, but it soon became evident that IP provides more flexible and economical solution, both for the circuit and packet switched networks. However, independently from the user plane technology, there has to be a mechanism to bind the control and user planes together. This functionality is provided by the binding ID, a session unique identity that is embedded into both signaling and user plane headers. The unique identity allows both ends of the signaling link managing the correct user plane connection. The idea is very simple but powerful. All 3G interfaces from base stations up to core network elements are utilizing this same approach.

The third invention related to the ATM Adaptation Layer type 2 (AAL2) (Bergenwall & Raivio 1998). The main invention was to adapt AAL2 multiplexing, not only to the 3G voice packetizing, but also to IP trunking. The IETF IP Telephony group standardized the IP trunking mechanism in 2002, but the final header structure slightly differentiated from the one that was proposed by the inventors.

3.2.2. IMS

The IETF search machine gives 164 RFCs hits for word SIP (IETF Search n.d.). The IMS as such is also a complicate ecosystem. SIP specifications include a lot of optional features and extensions. The versatility is also the reason for the interworking challenges between different SIP implementations (SIPKnowledge 2009). On the other hand, the user demand to IMS services does not exist yet. Most end users are satisfied with the basic, circuit switched, voice and text messaging services. For those users IMS does not bring any added value features.

IMS was supposed to offer Rich Communication Suite (RCS) with similar functionalities to internet messaging systems such as Microsoft Messenger, Google GTalk and Yahoo! Messenger. So far RCS has not deserved its position on end users' hands, in spite of the large operator and manufacturer investments. The opportunity window for IMS is closing. New technologies are coming to the market, which can soon make IMS with SIP and SIMPLE obsolete. Internet companies have already widely replaced SIMPLE with XMPP. XMPP has clear advantages when compared to SIMPLE (Levent-Levi 2008).

XMPP has been designed to support messaging and presence applications from the beginning, while SIMPLE consists of a set of SIP extensions to provide the same service. Using SIP for VoIP and SIMPLE for messaging and presence in IMS sounds a logical choice, but the synergy benefits seems to be low. Voice services can still be offered by the circuit switched technologies, while messaging and presence services can be implemented by other protocols, such as XMPP. The situation may change when LTE enters the mass market, but it still takes a long time before LTE is widely deployed. By that time totally new voice service technologies can be available. In the meantime, complicate interworking units are required between SIMPLE and XMPP domains (Saint-Andre, Houri & Hildebrand 2008).

3.2.3. RSS

Really Simple Syndication (RSS) protocol belongs to the Web 2.0 family. It was originally designed to distribute news. RSS offers a compact summary of the original and larger web sites. RSS is based on the pull method, e.g. an information fetch is initiated from end user's terminal. RSS utilizes a poll mechanism, connecting frequently, within certain time intervals, to the server. If the content has been updated, new information elements will be downloaded to the terminal. Otherwise connection is terminated without any action.

RSS also suits to mobile space, because the amount of data transfers is considerably small. As a tradeoff, the unnecessary poll messages create additional payload. In Publication II RSS was applied to mobile emergency announcement (MEA). Usually, public warnings are sent over SMS, but this approach has challenges, too. SMS notifications require global location registers, and furthermore, the total cost of transmitted messages will be high. According to the study, RSS based MEA is feasible, when it is compared to SMS or Cell Broadcast Service (CBS) based solutions. A summary of the comparison can be seen in Table 3. The optimum

between a feasible RSS poll period and a response time for the alarm can be adjusted depending on the circumstances. At the moment, the main challenge for mobile RSS usage is the low penetration of suitable terminals. However, the RSS readers are already emerging to low end mobiles, lowering the usage barrier.

Table 3. Comparison between RSS, SMS and CBS.

Criteria	**RSS**	**SMS**	**CBS**
Type	Pull	Push	Broadcast Push
Applicability	MEA & Info	MEA	MEA
Access	Any	Cellular	Cellular
Data types	Any	Text	Text
Availability	Bad	Good	Bad
Usability	Average	Good	Good
Security	Average	Good	Good
Privacy	Good	Bad	Good
Location	Terminal	Network	N/A
Reliability	Good	Average	Average
Scalability	Average	Average	Good
Cost	Bad	Average	Good

3.2.4. SMS push

In the future, pull based mobile applications will frequently transmit short data packets to a network and to other terminals. This information can consist of, for example, location, temperature, pressure and movement context data. This development will create a need for an efficient uplink data delivery. The usual packet data connection requires a considerable setup time, and due to the large overhead, it is an uneconomical transmission method for information elements that can be only a few bits in length. Today, SMS and smart messaging are the messaging services tailored for the mobiles, but unfortunately those services are not designed and standardized for mobile initiated, automated messaging.

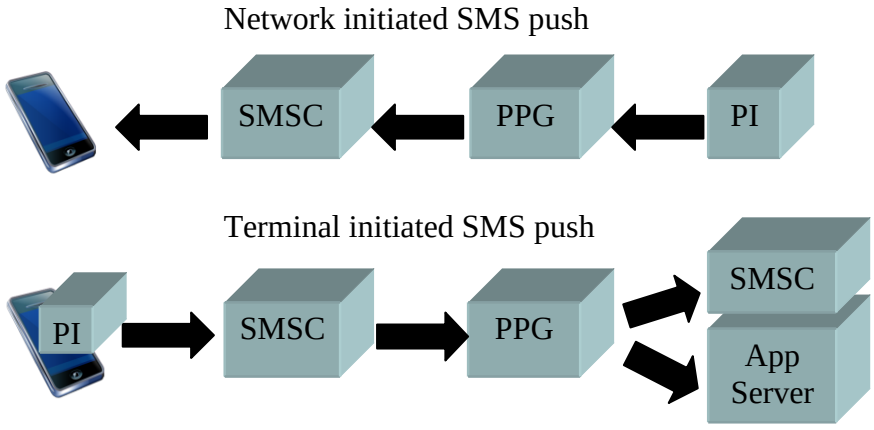

Figure 16. SMS push.

For those reasons an innovation, called terminal initiated SMS push, was created. The invention can be implemented with the existing wireless messaging protocols by allowing placing the push initiator (PI) functionality into the mobiles. Figure 16 presents both the normal, network initiated case, and the novel, terminal initiated case (Raivio, Alakoski & Varma 2008). When terminal wants to send data to the network or to another terminal, PI is invoked. A message is forwarded to the push proxy gateway (PPG) via SMS Centre (SMSC). PPG treats the push message according to normal procedures, and forwards it to an application server or to SMSC, and furthermore to another terminal.

3.2.5. Mobile P2P

Peer-to-peer (P2P) applications have been highly popular in the fixed internet. P2P provides an efficient content delivery network. A lot of studies have been made whether P2P networks could be applied to wireless networks, too. The main focus has been in WLAN networks, but also cellular networks could exploit the P2P principles. Figure 17 shows a generic mobile P2P architecture, where both cellular and WLAN domains have been connected to the P2P network. See details from Publication III. The P2P technologies as such will not work in the cellular space. Mobile terminals can be used for content downloading, but there are limitations for data sharing, due to narrow uplink bandwidth and limited battery life.

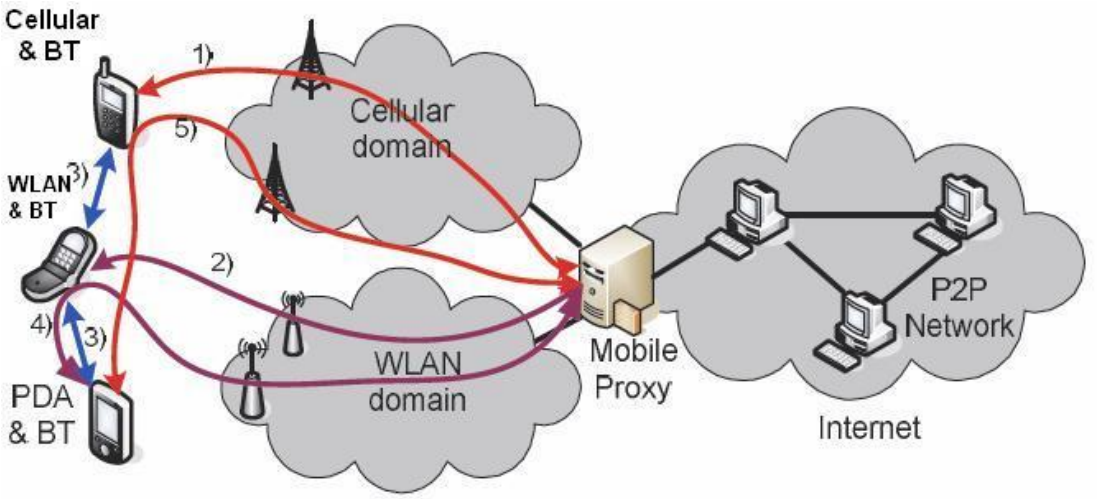

Figure 17. Mobile P2P architecture.

However, these restrictions can be, at least partly, solved by a mobile proxy. The main idea is that the mobile proxy, located in the fixed network, provides a mirror page of the mobile memory. These virtual mobile replicas are called edge peers, while the proxy represents a super peer towards external P2P networks. The main benefit of this arrangement follows from the fact that a lot of expensive wireless resources can be saved. The edge peers are always available, and their usage does not create any traffic over the air interface. The traffic between a mobile and an edge peer can be optimized and updated, for example, over night or using a fixed connection

through a PC. In the longer run, the need for a mobile proxy can diminish, when LTE networks with fast and cheap cellular links become widely available.

3.2.6. Open Telco architecture

The Open Telco architecture can be based on the service oriented architecture (SOA). Service delivery platform (SDP) is one implementation alternative for the SOA, and it is used here as a reference model. It consists of three main layers: secure APIs, support functions, and an adaptation layer, see Figure 18. Secure APIs offer the external view towards the network resources. They can be offered with common telecom technologies such as Parlay X, but web services, and especially the simplified REST (Representational State Transfer) framework is gaining popularity among developers (Makelainen & Alakoski 2008). Support functions are responsible about background actions such as security, identity management, privacy protection, community management, service level agreements (SLA), business processes and device management. SLAs are essential tools for small and medium enterprises (SMEs), who want to monitor the received QoS. In addition, the management of a developer community requires extensive support tools, including documentation and software development kits (SDKs).

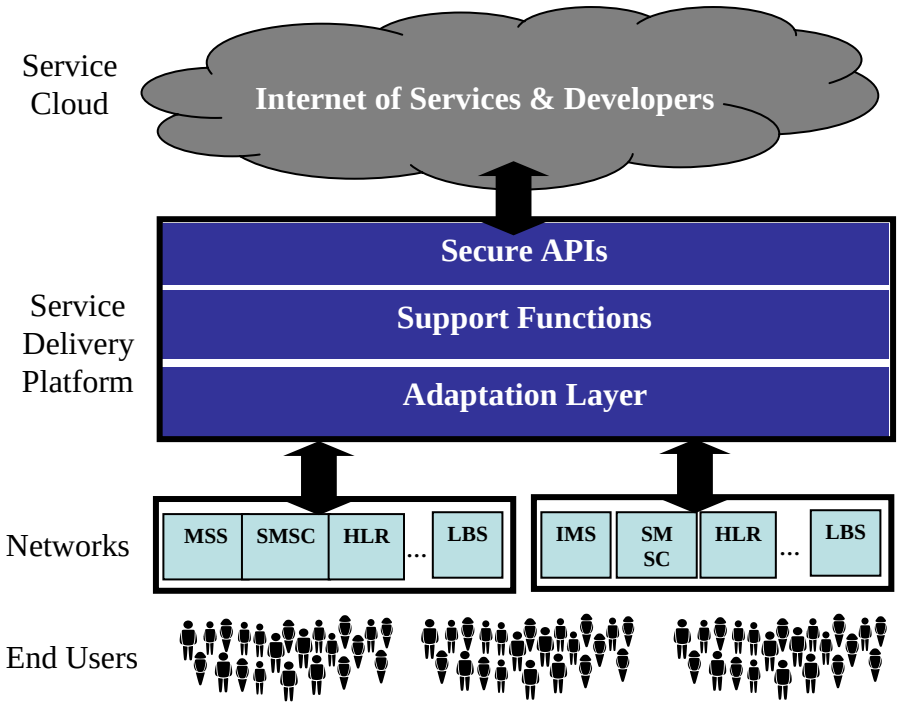

Figure 18. Open Telco architecture.

The adaptation layer includes intelligent data filters. The main challenge is the massive information flow. The same source data can be fetched from various network elements, and sometimes data can be even conflicting due to fluctuations on time intervals. The multi-operator and multi-vendor environment adds new challenges for the adaptation engine. In any case, the adaptation layer must transform the raw data to the format that can be efficiently utilized by the developers.

Additionally, the adaptation layer can support content caching that is often a necessary function to support optimized content delivery.

3.3. Organization

3.3.1. Broker

In the traditional telecommunications model, a service provider and a mediator are often part of the same organization, but even in this case, operators have - partly due to regulation - separated transport and service business from each other. A service client is usually an end user with a mobile phone. In the future, this triangle model does not solely apply, but the future systems can form from various mixtures. The role of broker becomes a current problem, whether the operators decide to offer open APIs for the developers. At the moment, operators often provide a plain bit pipe for developers. A larger internet company may make an exclusive agreement with an operator, leading to complicate and numerous point to point agreements. In the most advanced phase, a broker provides a neutral and equal entity between service providers and operators. SMS and roaming brokers are examples of this development. Publication V explores the broker case in detail. Figure 19 shows the evolution from a bit pipe to a broker architecture.

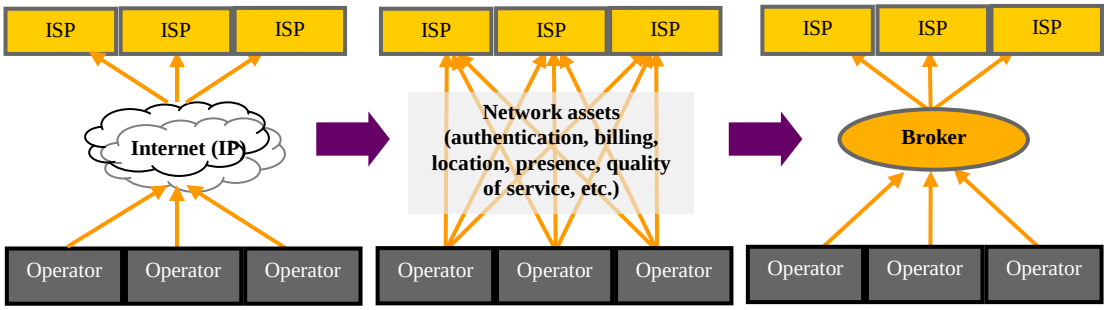

Figure 19. Broker evolution.

3.3.2. Value network

Value network is a suitable mechanism to describe organizational dependencies, in addition to identifying the fundamental value-creation processes in product creation. The Open Telco model represents a typical ICT service, which must support a multi-organizational structure. No single player can solely offer all necessary functions, but a successful service requires coherent co-operation between multiple resources and parallel actors. An example of the Open Telco value network has been depicted in figure 20. More details can be found from Publication VI.

The key role in the value network is dedicated for the broker. The system can consist of one or several brokers, depending on the market situation. Several brokers guarantee price competition, whereas one broker simplifies the functionality and

maximizes the network effect. All entities only establish a business relationship with a broker, which simplifies the agreement process. A broker is responsible about fair revenue sharing between the connected players. A broker host is an optional role in the case, when the broker is run, for example, in the computing cloud. Advertisers offer advertisements, which are embedded into the content by the broker, based on the end user profile. Several operators provide network and API resources in parallel. Also other industries can open their APIs. For example, public broadcasting companies can publish electronic program guides, and transportation enterprises can offer online commuting timetables. Developers and SMEs can create services by combining data from Open Telco APIs with the information fetched from the other APIs on mashup fashion.

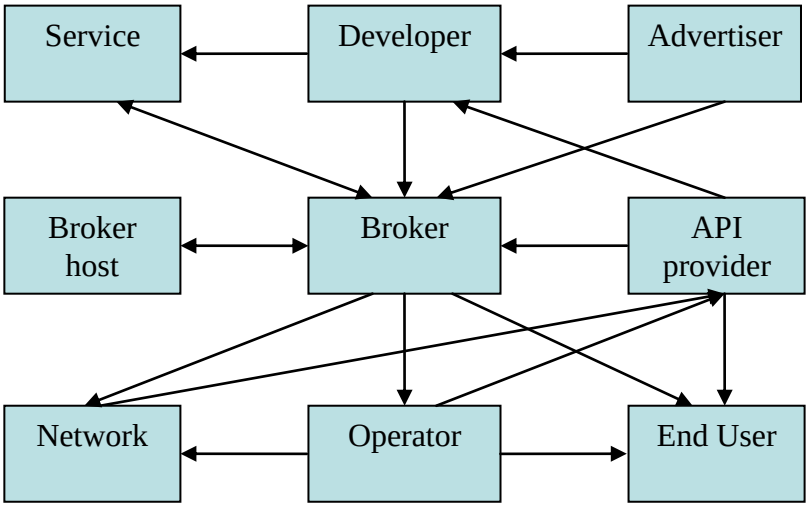

Figure 20. Value network for Open Telco.

3.4. Finance

3.4.1. Dynamic flat rate

Most mobile operators offer flat rate based charging system for their mobile data customers. The flat rate is a fair and equal method for all users, but it includes a few challenges. First of all, the all-you-can-eat charging system has been in danger due to heavy users, who have utilized mobile data worth gigabytes for P2P networking and video downloading. For that reason operators have been obliged to add restrictions to unlimited data usage. This approach is called a capped flat rate. On the other hand, a rigid flat rate does not bring any incentive to operators, because, independently of the usage, the data revenue is flat, too. For these reasons, mobile data requires new and innovative charging systems.

One proposal is called a dynamic or promotional flat rate, described in Publication III. The key idea is that the overdraft of the data limit will not convert to the volume based charging, but a customer is promoted to the upper data package. This approach encourages to a higher usage, and guarantees that the megabyte price will decrease upon the higher activity. The system must ensure that the price per bit will never

increase during the promotion. User classes, familiar from an airline industry, called gold, silver and bronze, can be utilized. See Figure 21.

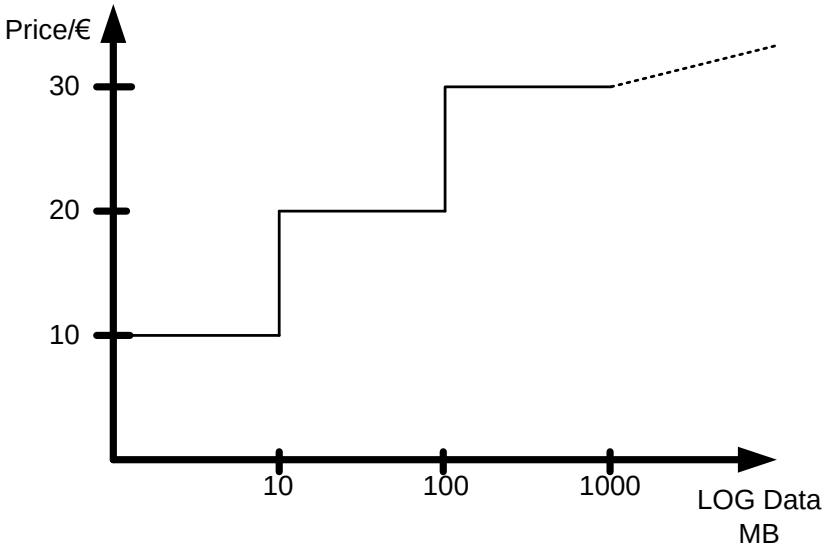

Figure 21. Dynamic flat rate.

3.4.2. Two-sided revenue model

Mobile industry can also benefit from two-sided revenue models. Operators have used to collect subscription fees only from subscribers, but in new models revenues can be charged also from content creators and advertisers. This system enables various revenue models, both between end users and operators, as well as between content creators and operators. Figure 22 shows a basic two-sided revenue model system in the operator field. A new feature is a subsidization that an operator can pay to end users. This mechanism enables several new revenue models, such as viral marketing, e.g. superdistribution. See also Publications IV and VI.

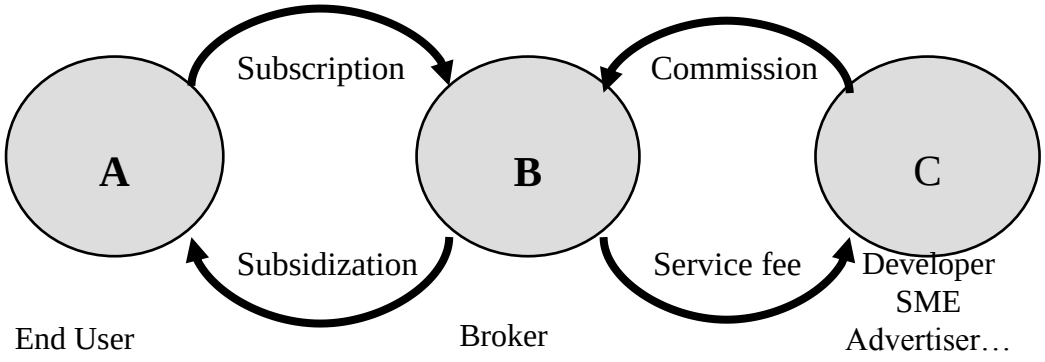

Figure 22. Two-sided revenue model.

Between an operator and a content provider the correct revenue sharing model is a challenge. For example, with premium SMS operators have used to get a major portion of the SMS price for themselves. However, the internet content providers

have a different view of the fair share. The mobile solution must be competitive with the internet alternative. The concept could follow Amazon and Yahoo! examples, where the companies collect a commission that is on the level of ten percent.

3.4.3. B-party pays

Several mobile services would benefit of a B-party pays concept. Currently, in most countries A-party, e.g. the side that originates a call, a message or a data connection, pays the whole session charge. This is very challenging for the services, where a content creator should send information within text messages or initiate phone calls to their customers. This problem would be solved by allowing a concept, where a receiver of the message or call could optionally accept the payment. There could be two service alternatives. Either, a service user can accept all messages and calls from a certain service, or dynamically allow single payments. The latter option would be a modernized form of the old collect call service. The B-party pays mechanism should be built on the call and message control systems, and it would support the Open Telco initiative described in Publication VI. The end users should have flexible web based tools to control the system settings.

3.4.4. Mobile advertising

Advertising is the most important Web 2.0 revenue model and also a natural alternative for mobile applications. However, a mobile phone as such is a challenge for an advertisement. The mobile display is small, and usually customers keep the device in their pockets. Also voice advertisements during the call have been trialed, but only with a modest success. On the other hand, the mobile space facilitates new type of opportunities. Blyk was one of the first mobile virtual network operators (MVNO), that utilized multimedia messaging service (MMS) for advertising. A key novelty in Blyk's concept was the targeted advertising. End users were asked their hobbies and other favorites, and the collected profile information was sold to advertisers. Although Blyk provided just basic end user profile data, the cost per millennium (CPM) value was a lot higher than with internet banners and emails.

Blyk's concept is the first step on profiling. However, it still incorporates very primitive methods. Mobile industry has a lot more opportunities to creation of advanced profiles. Operators know their customers very well, based on the long custom. In addition to the static profile data, operators can build a dynamic profile on their customers. Operators have a full call, messaging, browsing and location history from their subscribers. This data would be most valuable to the advertisers and information providers. However, due to privacy requirements, the real identities behind the profiles should be hidden. A broker would be a neutral party between an end user and an advertiser, guaranteeing the anonymity between the transactions. See also Publication VI for more details.

Although a mobile display is small and often in idle state, even a blank screen offers advertising opportunities. RSS based information flows can be shown on the idle screen, utilizing the wap push technology. Always after news is updated on the network, wap push message is sent to the terminal, and the RSS application in the

terminal is invoked. The terminal application connects to the network, and fetches new article titles. Those can be shown in scroll mode on the idle screen. The same mechanism can be applied to mobile advertisements, too.

3.4.5. Superdistribution

Pay-per-view, -use or -download methods separately charge end users upon each transaction. On frequent and small purchases this solution creates a lot of charging data, and can discourage consumers to use the service. Consumer-to-consumer (C2C) trading, such as P2P and superdistribution, will improve the system scalability, and more importantly, create the community aspect. Superdistribution provides new business opportunities, such as gifting and rewarding. The idea in gifting is that the user can recommend content to certain number of friends. They have a chance to use the content for a restricted time, and after the expiry of the trial period, they are offered a membership. Gifting acts here as a strong marketing scheme, and suits well for face-to-face type of cellular communities. The incentive in the superdistribution can be enforced by rewarding. The aim is to motivate the content sharing by giving a small compensation to the distributor on each chargeable C2C delivery.

Based on the analysis in Publication IV and evidence from the fixed Internet, superdistribution functionality, with gifting and rewarding options, is a mandatory new feature for mobile phones. Superdistribution clearly underlines the social behavior pattern, common among humans. On the other hand, DRM has only limited possibilities to stop piracy. The DRM solution is always a compromise of the usability and the protection level, and a small minority should not drive the decisions made for the majority. The best way to avoid the piracy is to make it obsolete by providing a better, legal alternative. Instead, DRM solution should support the superdistribution revenue model.

3.4.6. Creative pricing

Airlines have been very innovative with their pricing strategies. They invented attractive customer loyalty schemes, and lately also the dynamic pricing of the seats. Another field, the music industry, has also been struggling with the decreasing sales of CDs. Facing the fact, new startups have invented creative pricing schemes for music sales. See Publication IV. Flat rate charging system has also been applied to music downloading. One of the most successful new music services has been Spotify. It utilizes the right of usufruct principle. See Publication III. The idea is that the end user can listen, without restrictions, to the streaming music free with or without advertisements, by paying a small monthly fee. The end users will not get the original music files, but they just have the right of usufruct. Spotify music service is also ported into the mobiles.

Dynamic pricing has been tested also in the music sales. Magnatune record service asked the customer to define the price of the record, and the service just gave the minimum limit. Surprisingly, the record was not sold only with the minimum price but the average price exceeded the suggested price (Maney 2004). The same strategy was lately tested by Radiohead, that offered their record free in their web site. The

site was visited by 1.2 million visitors, from which 38 percent paid five euro in average per downloading the record (comScore 2007). Another creative example was shown by a German band called Einstürzende Neubauten that utilized donations. They asked their fans to donate 20 euro for the band, before the new record was even started to be made. The band received over 70 000 donations. As a compensation, fans got the new record earlier free and received access to exclusive support material.

4. Conclusions

The mobile industry has divided into two camps, namely the operators and the infrastructure vendors. The operators are still managing well while most of the infrastructure vendors have severe profitability challenges. Network equipment manufacturers are redirecting their core strategy from implementing the networks towards the operator services. Mobile operators have managed to maintain high profit levels, although the free Skype voice service provided a healthy warning about the future risks. The current closed, walled garden, approach has worked well until today, but the pressure from the Internet has forced the mobile operators to readjust their existing strategies. At the other extreme, operators can select the open model, where the operator just provides the transport solution in addition to mass market services. In the open model the other services will come from the Internet.

The main research question asked whether a hybrid model is the optimal solution to compensate for the declining ARPU figures. According to this study, the answer is positive. A hybrid model can utilize the strengths of both extreme alternatives. The literature review supports this conclusion. Shapiro & Varian (1999) testify that companies find the optimal reward between the open and closed models. Luukkainen (2008) calls the middle course between the extremes of evolution and revolution an 'evolutionary discontinuity'. The complete picture was gathered utilizing a research approach that was based on the STOF model (eds Bouwman, De Vos & Haaker 2008). It divides the business model research into service, technology, organization, and finance subcategories. The relevant literature and the corresponding research results were presented using the division mentioned above. The sub-research questions were also answered in those chapters.

First of all, the position of IP Multimedia Subsystem (IMS) is very challenging. Markets are lacking SIP capable mobile phones, and on the other hand, IMS applications are also missing from the market. McGrath (2001) warns about the hallucination. Enterprises see opportunities and create products for markets that do not exist or materialize a lot later. The worst of it is that the business case for IMS applications is missing. End users are satisfied with their current voice and text message services. Those services do not require any new infrastructure elements. LTE can change the situation, because backwards compatibility to the current networks can be in danger. However, the IMS functionality can be implemented in the MSC Server, too, making it a favorable choice for most operators.

Secondly, although several internet technologies have shown their power in the Internet, they cannot be directly copied to the mobile space (Jaokar & Fish 2006). The worst example are P2P networks that do not work without modifications in the mobile networks. On the other hand, the mobile specific protocols have a negative reputation. The benefits of global coverage are lost if the mobile terminals or networks require interworking units or other specific actions to work over fixed-mobile borders. On the one hand, a few internet technologies can be applied as such to mobile networks. For example, RSS is worth attention as an alternative to push

messaging. Widgets are another example that suit well for the mobile space. They render the original web pages to be usable also on the small screen.

Copyright is a controversial topic (Lessig 2005; Einhorn & Rosenblatt 2005). In the mobile space DRM technologies create even more challenges than in the fixed networks. The best alternative is to get rid of mobile copyright as far as possible. The latest development supports this vision. The right of usufruct is the core principle in the Spotify music service. Content services are clearly diverting towards a flat rate based charging model. In the revenue models this means a positive impact on subscription based, all-you-can-eat charging systems. Creative revenue models familiar in internet services should be applied to mobile services, as well. For example, ideas such as freemium (Wilson 2006) and viral marketing should be implemented in mobile services. OMA DRM 2.0 specification (OMA 2006) already supports these proposals.

The last part of the questions related to the Open Telco concept. The main idea is to open mobile infrastructure APIs for developers, and utilize a broker to connect multi-operator APIs through a common interface to the Internet. A bridge between the mobile and internet domains is clearly required (Loreto et al. 2009). The most compelling APIs are call control, messaging, location and payment, but also other assets exist. Operators have a wide selection of profile data from their customers, but the privacy laws restrict innovativeness. The need for a broker is not clear, either. A theory on brokering claims that the critical mass on both sides of the broker is required (Evans & Schmalensee 2008). At the beginning of the open API service launch the critical mass is missing. This means that a better solution is to start with the standardized APIs that most of the operators offer directly from their own network elements.

The main research method of this licentiate thesis was limited to the literature review. The future research work should verify the research results by experimentations and by analyzing the data retrieved from live networks. The MSC Server has already been verified and its success still continues. RSS based Mobile Emergency Announcements (MEA) have not been tested in a real case, but the core idea is still valid. The Mobile P2P architecture promotes the approach that part of the mobile intelligence should be located on the network side. This architecture optimizes the wireless link and improves content sharing between the end users. Furthermore, viral marketing should be added as a standard feature for the selling and sharing of mobile content.

The Open Telco concept is a major area where experimental research is required. A broker is one possible component of the Open Telco architecture and its role should be evaluated. Open APIs reveal totally new business opportunities, but also the risks should be evaluated. The research should be extended to include regulation and human factors. The privacy questions must be solved before the mobile networks can be opened. End user expectations must be tested with trials. Continuous experimentation is one of the major strengths of the Internet (Gaynor 2003). The same element should be transferred to the mobile networks, too. The current mobile service creation mechanisms do not support the open innovation (Chesbrough 2003). Often a better strategy is to try and fail fast than use long term planning.

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