AALTO UNIVERSITY
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# MOBILE COMMUNICATIONS INDUSTRY SCENARIOS AND STRATEGIC IMPLICATIONS FOR NETWORK EQUIPMENT VENDORS

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Technology.

Espoo, April 10th 2010

Supervisor: Professor Heikki Hämmäinen

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AALTO UNIVERSITY
SCHOOL OF SCIENCE AND TECHNOLOGY Abstract of Master's Thesis


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Mobile infrastructure markets have changed dramatically during the past years. Overall network equipment markets have declined gradually as operators have reduced capital investments. This has driven the shift from traditional large-scale, hardware-driven system roll-outs to software and services –driven business models. At the same time operators modernize their networks to IP-based solutions decreasing the barriers of IT and computer-oriented vendors to enter the telecom-specific equipment markets. In applications and service domain internet service players are gradually taking over the traditional businesses of mobile operators by offering a variety of disruptive services accessible via a simple internet connection. The objective of the thesis is to prepare established telecom vendors for possible future mobile communications industry scenarios of different value configurations.

Mobile communications industry background is introduced before possible future scenarios are constructed. Industry background chapter discusses relevant technological and economical aspects of today's mobile communications industry. The scenario construction process is initiated with a study of the current mobile infrastructure market structure. After that the most important forces shaping the markets are gathered using PEST analysis and assessed in terms of importance and uncertainty utilizing data from expert interviews. Based on key uncertainties four scenarios are constructed describing possible value systems between stakeholders involved in mobile industry. Finally, based on the scenarios strategic implications for established telecom vendors are discussed utilizing Michael Porter's framework of strategic approaches under industry uncertainty.

The four boundary scenarios of mobile communications industry are intended to help the stakeholders involved to address the industry uncertainties in a new manner. It is emphasised that implicit forecasts about the future and the underestimation of radical or discontinuous changes should be avoided when conducting strategic planning in organizations. The formulated five strategic approaches imply that telecom vendors have several choices to prepare for possible futures of industry evolution. Constructed scenarios and strategic frameworks may assist managers to make informed decisions based on explicit views about the future and be aware of the set from which the selected approach or a set of approaches is chosen.


Keywords: Mobile industry; network equipment vendor; scenario planning; strategies

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Mobiili-infrastruktuurimarkkinat ovat muuttuneet dramaattisesti viime vuosien aikana. Verkkolaitemarkkinat kokonaisuudessaan ovat pienentyneet operaattoreiden vähentäessä investointejaan. Tämä on edistänyt liiketoimintamallien muutosta tavanomaisista laajamittaisista laitetoimituksista kohti ohjelmisto- ja palvelukeskeisiä liiketoimintamalleja. Samanaikaisesti operaattorit modernisoivat verkkoinfrastruktuuriaan IP-pohjaiseksi kasvattaen IT-orientoituneiden toimittajien mahdollisuutta astua mobiili-infrastruktuurimarkkinoille. Loppukättäjille tarkoitettujen sovellusten ja palveluiden alueella operaattorit kokevat internet-pohjaiset palvelut kasvavana uhkana tavanomaisten puhe- ja viestintäpalveluiden korvaajina. Tämän diplomityön tarkoituksena on valmentaa perinteisiä mobiili-infrastruktuuritoimittajia mahdollisten mobiili-liiketoimintaskenaarioiden ja niissä vallitsevien arvokonfiguraatioiden varalle.

Ennen kuin mahdolliset tulevaisuuden skenaariot rakennetaan, mobiili-liiketoimintaympäristön taustaa esitellään. Tässä yhteydessä olennaiset teknologiset ja liiketoiminnalliset näkökulmat tuodaan esille. Skenaariosuunnittelu aloitetaan tutkimalla ensin nykyisen liiketoimintaympäristön rakennetta mobiili-infrastruktuurimarkkinoilla. Tämän jälkeen PEST analyysiä hyödyntämällä kerätään joukko makro-tason voimia, joilla todetaan olevan vaikutus mobiili-liiketoiminnan tulevaisuuteen. Asiantuntijahaastatteluja hyödyntämällä kerättyjä voimia arvioidaan tärkeyden ja epävarmuuden perusteella. Tärkeimpien epävarmuuksien perusteella kehitetään neljä skenaariota kuvaamaan mahdollisia arvojärjestelmiä tärkeiden osapuolien keskuudessa. Lopuksi skenaario-kuvauksia ja Michael Porterin teorioita hyödyntämällä tehdään strategisia johtopäätöksiä mobiili-infrastruktuuritoimittajien näkökulmasta.

Kehitettyjen mobiili-liiketoimintaympäristöjen arvojärjestelmiä kuvaavien ääriskenaarioiden odotetaan avustavan liiketoiminnan osapuolia ottamaan vallitsevat epävarmuudet paremmin huomioon. Diplomityössä korostetaan välttämään implisiittisiä odotuksia tulevaisuudesta sekä varomaan mullistavien ja liiketoimintaympäristöä merkittävästi muuttavien muutosten aliarvioimista strategisen suunnitteluprosessin yhteydessä. Viisi kehitettyä strategista lähestymistapaa antavat ymmärtää, että mobiili-infrastruktuuritoimittajilla on useita toisistaan eriäviä mahdollisuuksia varautua liiketoimintaympäristön epävarmuuksiin ja kehitykseen. Kehitetyt skenaariot ja strategiset johtopäätökset voivat auttaa yrityksen johtohenkilökuntaa tekemään tietoisia päätöksiä, jotka pohjautuvat selkeästi esitettyihin näkemyksiin mahdollisista liiketoimintaympäristön tulevaisuuden etenemissuunnista.

Avainsanat: Mobiili-liiketoiminta; verkkolaitetoimittaja; skenaarioanalyysi; strategiat

# Preface

This Master's Thesis has been written as a partial fulfillment for the Master of Science degree in Aalto University School of Science and Technology.

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Espoo, April 10, 2010

Hannu Enqvist

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# List of abbreviations

| | |
|---|---|
| 2G | Second Generation |
| 3G | Third Generation |
| 3GPP | the Third Generation Partnership Project |
| 4G | Fourth Generation |
| AAA | Authentication, Authorization and Accounting |
| AP | Access Point |
| API | Application Programming Interface |
| ARPU | Average Revenue Per User |
| ATCA | Advanced Telecommunications Computing Architecture |
| BOT | Build-Operate-Transfer |
| BPO | Business Process Outsourcing |
| BS | Base Station |
| BSS | Business Support System |
| BTS | Base Transceiver Station |
| CAPEX | Capital Expenditures |
| CN | Core Network |
| COTS | Commercial Off-The-Shelf |
| CP-TA | Communications Platforms Trade Association |
| CRM | Customer Relationship Management |
| CS | Circuit-Switched |
| EDGE | Enhanced Data rates for GSM Evolution |
| eNB | evolved NodeB |
| EPC | Evolved Packet Core |
| ERP | Enterprise Resource Planning |
| eUTRAN | evolved UTRAN |
| FCAPS | Fault, Configuration, Accounting, Performance, Security |
| GERAN | GSM EDGE Radio Access Network |
| GPRS | General Packet Radio Service |
| GSM | Global System for Mobile communications |
| HLR | Home Location Register |
| HSPA | High-Speed Packet Access |
| HSPA+ | Evolved High-Speed Packet Access |
| HSS | Home Subscriber Server |
| ICT | Information and Communication Technologies |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineering |
| IM | Instant Messaging |
| IMS | IP Multimedia Subsystem |
| IP | Internet Protocol |
| IP/MPLS | Internet Protocol/Multi-Protocol Label Switching |

| | |
|---|---|
| ISV | Independent software vendor |
| ITU | International Telecommunication Union |
| ITU-R | The ITU Radiocommunication Sector |
| ITU-T | The ITU Standardization Sector |
| LA | Local Area |
| LTE | Long Term Evolution |
| MA | Metropolitan Area |
| M2M | Machine-to-Machine |
| MBB | Mobile Broadband |
| MBNL | Mobile Broadband Network Limited |
| MME | Mobility Management Entity |
| MNO | Mobile Network Operator |
| NBI | North-Bound Interface |
| NGN | Next Generation Network |
| NGOSS | New Generation Operations Systems and Software |
| OAM | Operations-Administration-Maintenance |
| OEM | Original Equipment Manufacturer |
| OPEX | Operational Expenditures |
| OSS | Operations Support System |
| PCI | Peripheral Component Interconnect |
| PDA | Personal Digital Assistant |
| PEST | Political, Economic, Social, and Technological |
| PICMG | PCI Industrial Computer Manufacturers Group |
| PS | Packet Switched |
| QoE | Quality of user Experience |
| QoS | Quality of Service |
| RAN | Radio Access Network |
| SAE | System Architecture Evolution |
| SDM | Subscriber Data Management |
| SDN | Software-Defined Network |
| SDP | Service Delivery Platform |
| SDR | Software-Defined Radio |
| SI | Systems Integration |
| SIM | Subscriber Identity Module |
| SIP | Session Initiation Protocol |
| SOA | Service Oriented Architecture |
| SON | Self-Organizing Network |
| TCO | Total Cost of Ownership |
| TMN | Telecommunications Management Network |
| UMTS | Universal Mobile Telecommunications System |
| UTRAN | UMTS Terrestrial Radio Access Network |
| WCDMA | Wideband Code Division Multiple Access |

| | |
|---|---|
| WIAP | Wireless Internet Access Provider |
| Wi-Fi | Wireless Fidelity |
| WiMAX | Worldwide Interoperability for Microwave Access |
| WLAN | Wireless Local Area Network |
| VoIP | Voice over Internet Protocol |
| VPN | Virtual Private Network |

# 1 Introduction

## *1.1 Motivation*

Telecom infrastructure markets have changed dramatically during the past years. Overall network equipment markets have declined gradually as operators have reduced capital investments partly because of the economical crisis hitting the global markets in 2008. The global telecom infrastructure market is expected to remain flat or show a slight increase within the coming years. One major change in the telecom infrastructure market is the shift from traditional large-scale, hardware-driven system roll-outs to software and services-driven business models. Few decades ago the telecom hardware represented the main role and it was the primary differentiator in telecom systems. However, during the last decade the differentiating functionality of communications networks has shifted mostly to software components making hardware more or less a standardized platform. Today mobile connectivity and even mobile broadband access is increasingly considered as commodity by end-users. This evolution is increasing the hardware price erosion and making software and services the main differentiators in the entire telecom industry.

The changing nature of the mobile services ecosystem has developed an increasing threat facing traditional telecom vendors. Major platform vendors providing hardware and operating system platforms and IP-networking vendors are increasingly able to provide traditional telecom operators directly with solutions and services. One of the strongest drivers is the migration from telecom-specific solutions to IP-based systems. High cost pressures are forcing operators to modernize their networks in order to minimize the cost per megabyte and migration to IP and Ethernet-based solutions is the best way to cope with the revenue gap[1] issue. As mobile networks gradually turn into all-IP environments beginning from the core and backhaul networks, increasingly more generic network elements and management systems have capabilities to provide the underlying networking infrastructure. It is yet to be seen how long and to what degree telecom-specificity remains in mobile infrastructure systems, and should it disappear, what are the impacts to telecom infrastructure value chain and the traditional roles adopted by telecom, platform and IP-networking vendors.

One critical uncertainty about the future is how the traditional mobile operators will position themselves in the future mobile services ecosystem. Internet world is gradually taking over the traditional businesses of mobile operators by offering a variety of services usable with a simple

[1] Essentially, revenue gap means the trend that traditional voice revenues are declining while wireless data traffic is increasing and flat-rate data plans are diffusing. There is more discussion about this phenomenon in the next chapter.

internet connection. Instant messaging (IM), VoIP and other disruptive services are decreasing traditional operator revenues increasing the operators' fear of becoming sole bit carriers. These forces are shaping the entire telecom value network as mobile operators are searching ways to minimize both operational and capital expenditures. Mobile operators are increasingly demanding services from their vendors and outsourcing their non-core competence processes and operations to vendor partners, changing the traditional roles of vendors, operators and service providers.

## *1.2 Research questions*

Major changes have occurred and will occur in the future as telecom and internet worlds are clashing both in the service and networking technology domains. Some of the main drivers behind these changes were discussed above and will be discussed in more detail in the following chapters throughout the thesis. In order to better understand the possible future directions of industry evolution and the impacts to the roles and positioning of existing stakeholder groups - especially the traditional telecom vendor group - the following main research questions were formulated.

1. What are the different possible value configurations between operators and vendors in the future (2015) and

2. How should telecom infrastructure equipment vendors formulate their strategy to best cope with them?

## *1.3 Scope*

The scope of the thesis is intentionally kept rather broad in order to get a holistic view of possible future industry outcomes. However, some boundaries are needed to ensure that research results will not be too general. In terms of industry stakeholders the key focus throughout the thesis is held on incumbent mobile operators and traditional telecom vendors providing mobile infrastructure solutions and services. Also the relationship between these two industry players is closely observed. The time-frame is limited to five years ranging from 2010 to 2015 to some extend mitigate the most extreme changes brought by technological and industry ecosystem evolution. By choosing a time-frame of five years it is also easier to compare the present business ecosystem and the ones in possible future scenarios. In terms of technology the scope is mainly narrowed to mobile infrastructure technologies and their possible substitutes from the more internet-oriented technology standards (i.e. mainly IEEE[2] technologies).

[2] http://www.ieee.org/

## 1.4 Methods

The research methods utilized in the thesis are listed below.

- Literature study
- Scenario planning
- Analysis based on theoretical frameworks
- Interviews

Literature study is mainly conducted for the Industry background (see chapter 2) and Scenarios (see chapter 4) chapters in the thesis. Background information about the current industry ecosystem and technological landscape of mobile infrastructure was gathered. Additionally, literature sources were studied in order to support industry forces gathering during the scenario construction process. The sources of literature study included industry news, company press releases, research papers, white papers and industry-related books.

A scenario planning technique is utilized in order to create four possible future scenarios for telecom industry value systems. As a scenario planning framework a process called Schoemaker's method is utilized which is described in more detail in chapter 3 (see section 3.1).

Theoretical frameworks utilized in the thesis include PEST categorization and Michael Porter's frameworks of industry analysis and strategy formulation. PEST framework is a useful tool to collect and categorize essential industry forces and it is utilized during the scenario construction process. Porter's five-force model is also used in the scenario construction process in order to study the current industry structure of telecom equipment markets. After the scenarios are constructed strategic implications for telecom equipment vendors are discussed utilizing Porter's framework of strategy formulation under industry uncertainty. PEST model and Porter's frameworks are described in more detail in chapter 3.

Industry expert interviews are conducted mainly during the scenario construction process. During the scenario construction process interviews are utilized to assess the importance and probability of different market forces impacting the telecom industry at present and within the next five years. Additionally, based on the interviews the scenario probabilities and feasibility to the key stakeholder group (i.e. telecom equipment vendor) are discussed.

## *1.5 Structure*

The structure of the thesis (chapters and research methods) is presented in Figure 1.

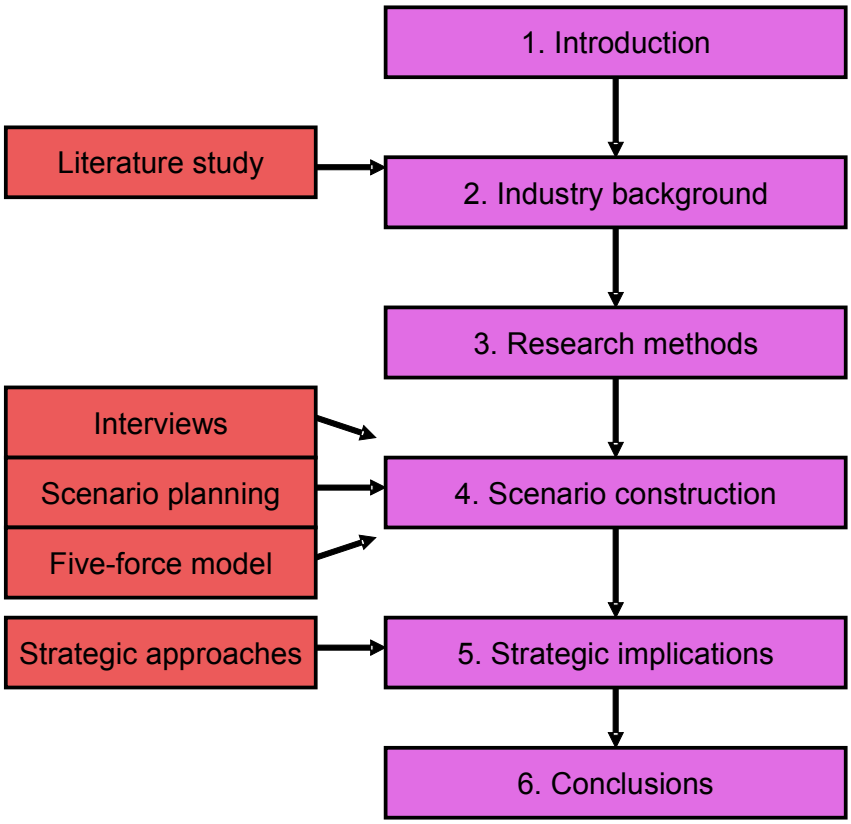


Figure 1: The structure of the thesis

After the introduction a brief industry background chapter follows. This chapter elaborates the factors behind most important market forces described previously. After industry background section the research methods and theoretical frameworks utilized in the thesis are described in more detail. The next chapter describes the scenario construction process utilizing a combination of Schoemaker's scenario planning process and PEST framework. After the scenarios are constructed strategic implications for telecom equipment vendors are discussed based on the Porter's five generic strategic approaches under industry uncertainty.

# 2 Industry background

## *2.1 Technological background*

Technological mobile and wireless network infrastructure are described below on an abstract level. The main idea of this section is to provide the reader with a generic introduction of wireless technology infrastructure and management systems. This section acts as a basis for the following section where telecom industry value network and stakeholders are discussed (see section 2.2). The intention is that by understanding the general technological environment it will be easier to place different stakeholders to the mobile business ecosystem.

### 2.1.1 Mobile and wireless network infrastructure

A high-level illustration of traditional mobile network infrastructure is presented in Figure 2.

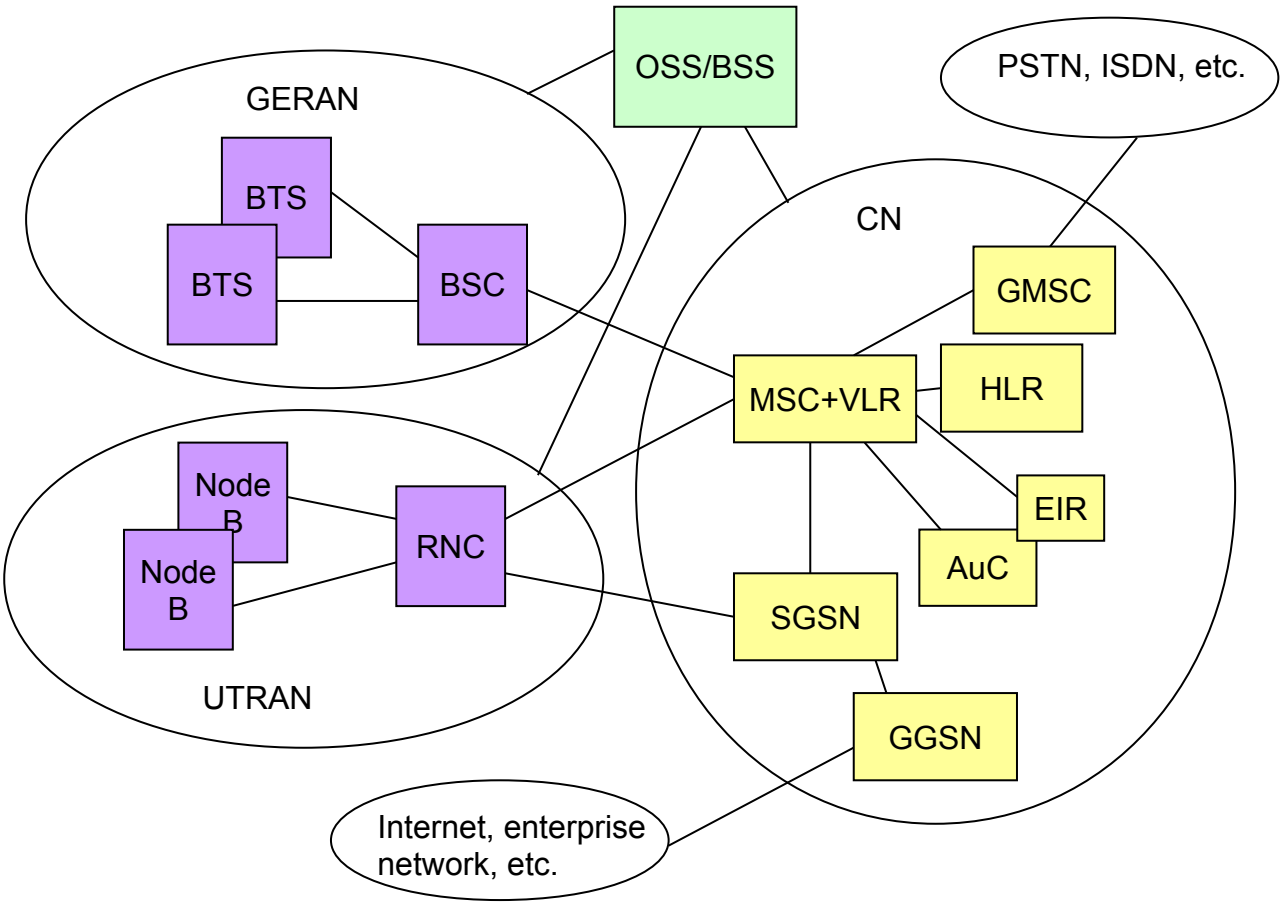


Figure 2: Mobile network infrastructure (adapted from Tirkkonen (2008))

Mobile infrastructure constitutes mainly of two parts – Radio access network (RAN) and core network (CN). On the left side of Figure 2 RAN parts of the mobile infrastructure are presented –

GSM EDGE RAN (GERAN) and Universal terrestrial RAN (UTRAN) for GSM and UMTS networks, respectively. The main purpose of RAN is to connect mobile devices to the operator core network via a standardized air interface and mobile backhaul for further routing. The main components or network elements (NE) of RAN are base stations (BS) and base station controllers – base transceiver station (BTS) and base station controller (BSC), and node B and radio network controller (RNC) in GSM and UMTS networks, respectively. Figure 2 also illustrates the conceptual positioning of network management systems (OSS/BSS will be discussed more in detail in the following section).

The right-hand side of Figure 2 presents the mobile core network. A mobile core network may include the following elements/functions (Tirkkonen, 2008).

- Mobile Switching Centers (MSC)
- Location databases (HLR, VLR)
- Authentication and equipment identity databases (AuC, EIR)
- Gateways to other networks such as Internet or PSTN (GMSC, GGSN)
- Or any other elements that can perform similar functions, e.g. all-IP core

The network components, their functions and interfaces between them are not discussed in detail as the thesis scope is intentionally kept broad in order to study the industry evolution from a holistic point of view (see section 1.3). In general, the core network elements and the interfaces between them are still very telecom-specific in 2G and 3G networks. However, as was briefly discussed in the introduction section (see section 1.1) mobile operators increasingly modernize and upgrade their networks to more efficient, IP-based solutions. The result is that operators gradually replace traditional telecom-specific equipment that was originally designed for carrying and managing voice traffic with more IP-centric equipment and solutions.

In order to develop existing mobile technologies 3GPP is specifying a new set of standards for the future LTE[3] (Long Term Evolution) network system. This description was first provided in 3GPP Release 8 specification (3GPP, 2009) and its main targets are to tackle following issues.

[3] LTE is 3GPP's global next-generation mobile radio access technology standard that is considered to be a 'pre-4G' solution providing a migration path to 'real' (=meets ITU-R's requirements for 4G technology (IMT-Advanced)) 4G mobile networks.

- Reduced latency
- Higher user data rates
- Improved system coverage and capacity with lower TCO for operators
- OPEX and CAPEX savings with a common IP-based network

This new System Architecture Evolution (SAE) introduces a flat, all-IP infrastructure constituting of eUTRAN as an evolution of existing UTRAN and Evolved Packet Core (EPC) as an evolution of existing GPRS packet core. A general view of future flat, all-IP mobile infrastructure is presented in Figure 3.

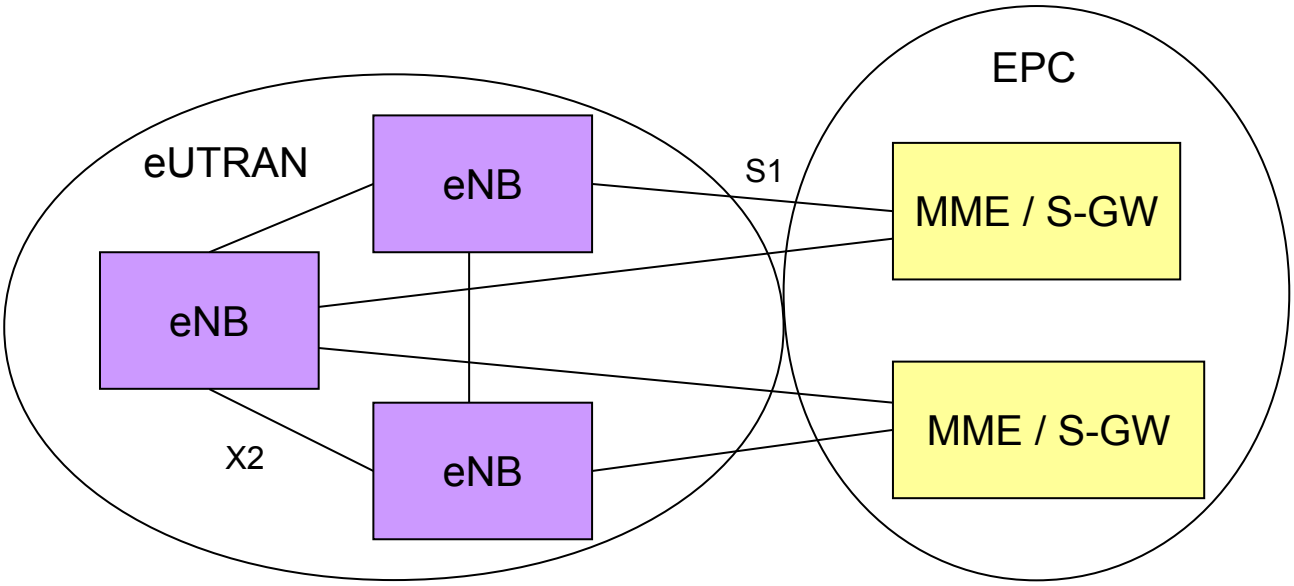


Figure 3: Future all-IP mobile infrastructure (adapted from 3GPP (2009))

The eUTRAN consists of eNodeBs (eNB) which are evolved versions of 3G NodeBs. eNBs are directly connected to the EPC making the infrastructure “flat”. On the signaling plane eNBs are connected to Mobility Management Entity (MME) and on the user plane eNBs are connected to Serving Gateways (S-GW). Every eNB is interconnected with each other by the X2 interface and to the EPC by the S1 (u/c) interface. The architecture supports efficient IP-based communication and technology aggregation of many different mobile and wireless access technologies such as HPSA+, LTE, WiMAX and Wi-Fi.

### 2.1.2 OSS/BSS systems

Operations and business support systems (OSS/BSS) are critical elements of every network regardless of the underlying technology. OSS/BSS solutions constitute of both network and service layer management functions. There exist many different concepts to describe the functional areas of network management systems. One commonly utilized model to illustrate the different layers and functions of OSS/BSS is the five-layer TMN Network Management Architecture defined by ITU-T (IEC, 2007). ITU-T also classifies the general functionality of OSS systems into five categories – fault, configuration, accounting, performance and security (FCAPS). These functionalities can be realized in every layer of the TMN model. Figure 4 illustrates the layered TMN model and FCAPS relations.

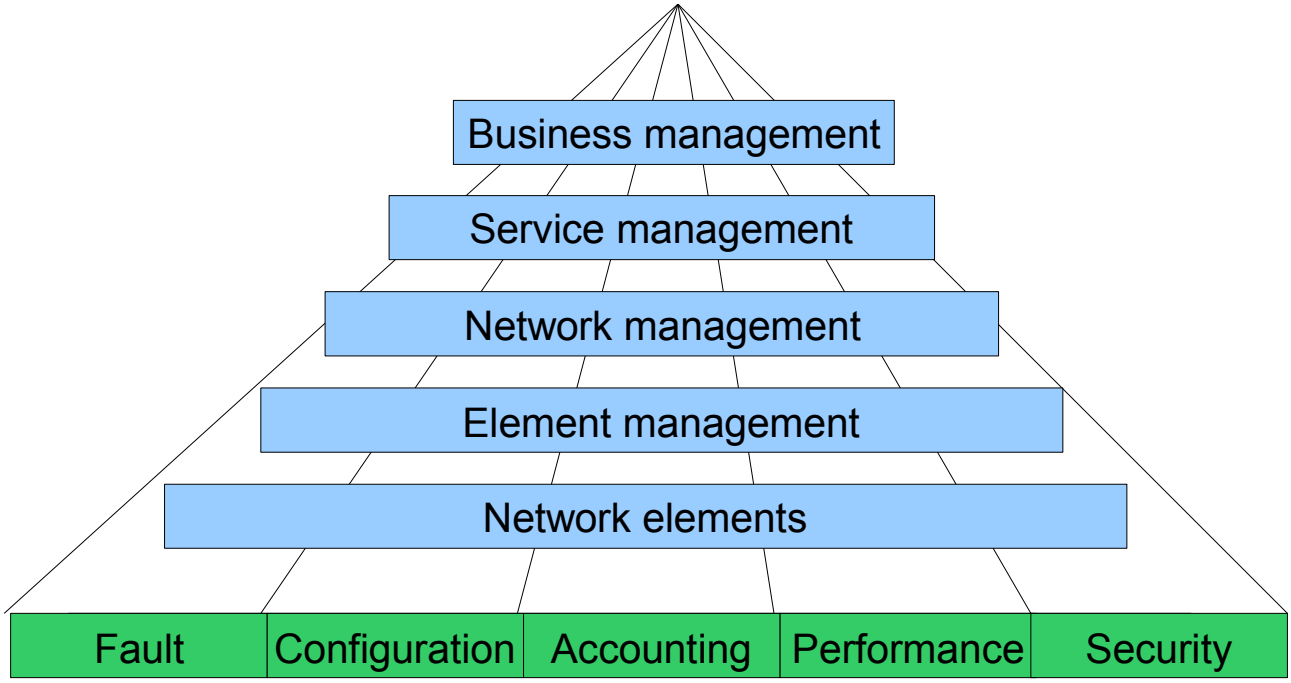


Figure 4: TMN Network Management Architecture with FCAPS (adapted from IEC (2007))

Figure 4 presents the five functional levels of telecommunications management – business management layer (BML), service management layer (SML), network management layer (NML), element management layer (EML), and network element layer (NEL). FCAPS functionality is not described in detail as it is seen as too detailed considering the thesis scope. However, the five layers of TMN model are important as by understanding the purpose of each layer it will be easier to define which industry stakeholders address different parts of operator OSS/BSS management systems within the industry. Table 1 describes the main purpose and functions of different TMN layers.

Table 1: TMN layers and their functionality (adapted from IEC (2007))

| | |
|---|---|
| Business Management Layer (BML) | Management of overall business, e.g. achieving return on investment, market share, employee satisfaction |
| Service Management Layer (SML) | Management of services offered to customers, e.g. meeting customer service levels, service quality, costs and time-to-market goals |
| Network Management Layer (NML) | Network management, e.g. capacity and congestion management |
| Element Management Layer (EML) | Management of individual NEs' functions and capabilities |
| Network Element Layer (NEL) | NEs, e.g. switches, routers, BS, servers, gateways, databases |

## *2.2 Communications industry value network*

The traditional mobile services value network can be considered as a combination of three distinct value chains – access, services and devices. Figure 5 describes these three value chains combined to form the mobile services value network representing different stakeholders in the ecosystem. It should be remarked that the ovals in figure represents actors who can adopt different business roles within the value network. Considering the thesis scope access value chain in the middle will be under closer observation than the upper device chain and services chain on the bottom of Figure 5. Also, throughout the thesis the main interest is to study the evolving vendor-operator relationship in different communications industry scenarios.

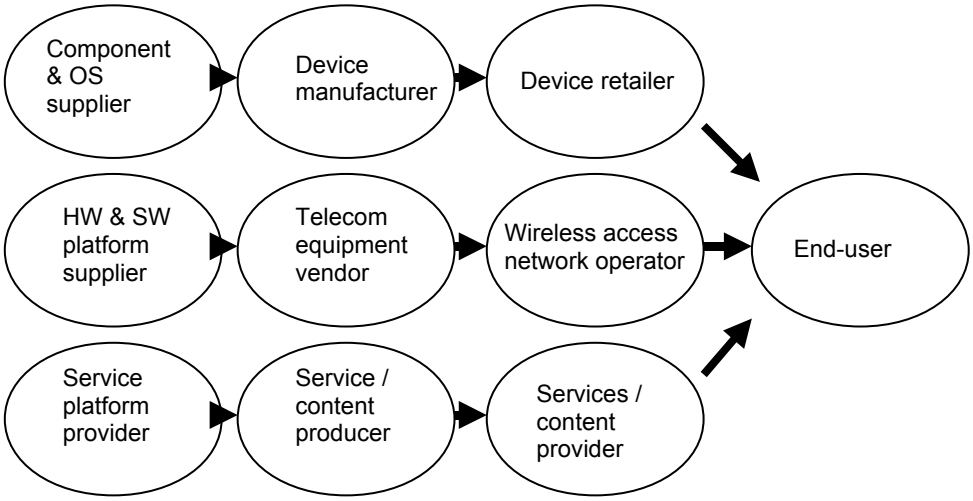


Figure 5: Today's mobile services value network (adapted from Smura and Sorri (2009))

One distinct stakeholder group in today's telecom services value network is the datacom equipment and service provider stakeholder group. Traditionally this stakeholder group is excluded from diagrams representing the telecom industry but the rapid change in technology and the convergence of telecom and internet worlds bring the datacom vendors more intensively to the illustration, especially when vendors are in the center of the study. By the term datacom vendor it is usually referred to industry stakeholders serving more IT-related business areas such as enterprise back-office solutions (i.e Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP)) and enterprise data-networking environments including IT and networking hardware, software and related services. Historically, the connectivity between people and devices – especially in terms of telecommunications – has been provided by telephone operators via their highly specific telecom infrastructure. Today however, the convergence of the traditional telecom access (mobile and fixed-line telephony) and internet access shape the entire value configuration, also including the supply side of telecom and IP-based infrastructure. Traditional telecom vendors face new threat increasingly from the internet and computer infrastructure vendors. Major hardware and operating system (OS) platform vendors, independent software suppliers (ISV) and IP-networking equipment vendors are expanding their businesses to telecom markets more intensively. With the thesis scope and above mentioned industry characteristics in mind a modified value network (or more likely a value system or value configuration) of mobile communications industry is presented in Figure 6. The stakeholders in Figure 6 are discussed in the following section.

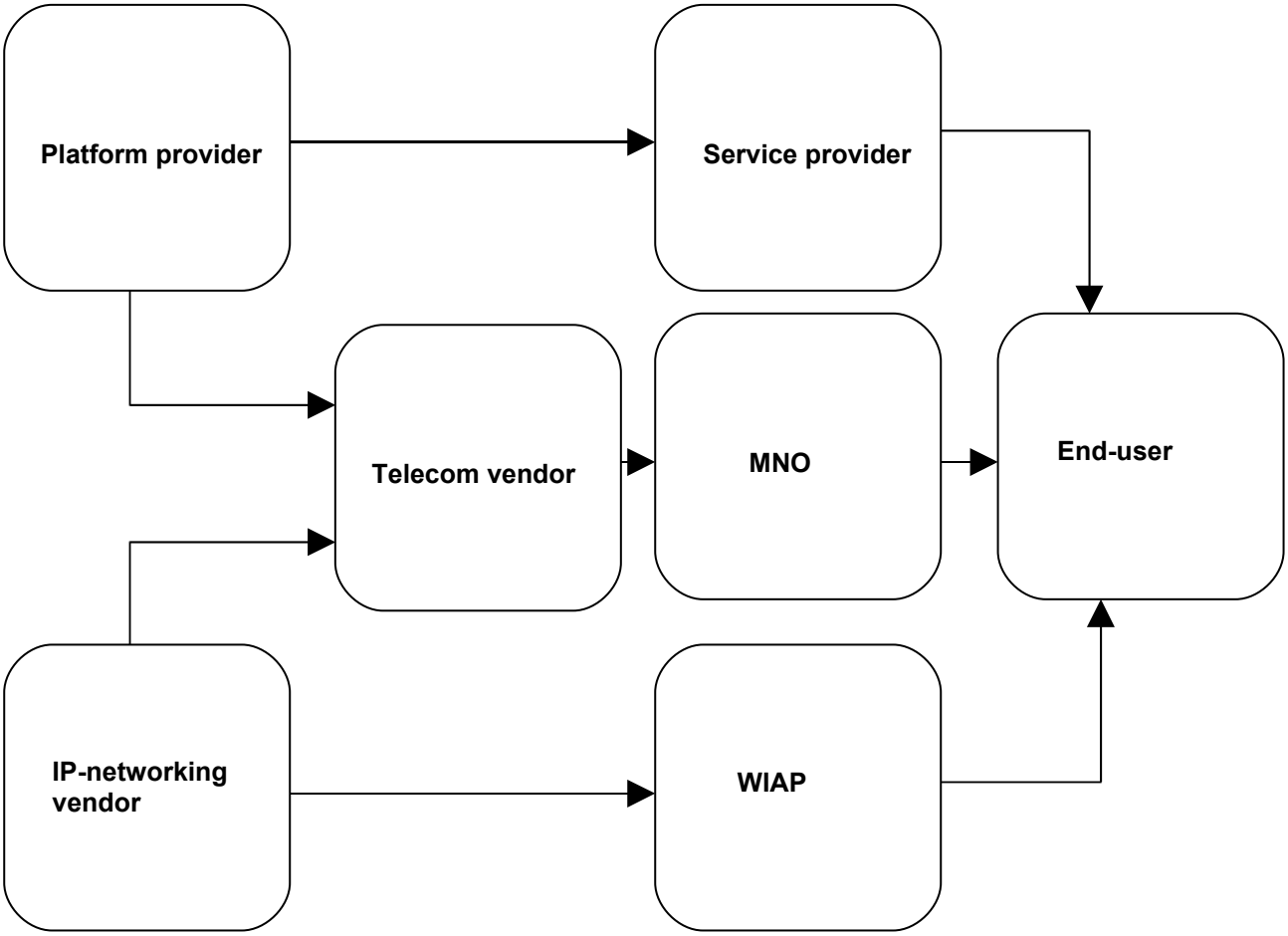


Figure 6: Modified mobile services value configuration[4]

### 2.2.1 Stakeholders

The stakeholder groups presented in Figure 6 are discussed below.

#### Telecom vendor

Telecom vendors are direct suppliers for mobile operators (MNO) providing them with network systems (RAN, CN, OSS/BSS) including physical network elements, software solutions and professional services. There exist a lot of terminology to describe this industry actor such as telecom OEMs, established telecom equipment vendors and networking technology vendors but the term 'telecom vendor' is used throughout the thesis to describe a traditional telecommunications infrastructure vendor - an industry stakeholder who provides mobile operators with mobile network infrastructure solutions and related services. Examples of major telecom vendors are Ericsson[5],

[4] Because of the thesis scope the device value chain is left out from the figure.
[5] http://www.ericsson.com/

Nokia Siemens Networks[6], Huawei[7] and Alcatel-Lucent[8]. The single arrow from telecom vendor to MNO in Figure 6 implies that MNOs are telecom vendors' main customer segment although telecom vendors provide Wireless Internet Access Providers (WIAP) and other operators (CN, fixed, cable, etc.) with solutions and services as well.

## MNO and WIAP

The role "wireless access network operator" in Figure 5 was divided into two distinct stakeholder groups – mobile network operators (MNO) and Wireless Internet Access Providers (WIAP). Incumbent MNOs traditionally operate on licensed spectrum and utilize technologies based on 3GPP or 3GPP2 standards in Europe and in the U.S., respectively. WIAPs are represented by operators offering access with IEEE technologies. This group can be divided into two main groups; (1) commercial WiMAX operators and (2) venue owners such as households, enterprises and communities deploying their own Wi-Fi networks. These actor groups were chosen based on the idea that telecom vendors' main customers are the MNOs, and the WIAP players described here pose the most credible threat for MNOs with disruptive business models and technologies.

## Service provider

When the future mobile communications industry scenarios are considered one of the most interesting stakeholder groups are the service providers of mobile content and services. Service providers are responsible for delivering a variety of services and content, including basic voice and messaging services, content (e.g. music, videos and maps), applications and internet-based communications such as VoIP and IM to end-users. Today, more and more services are delivered by major internet service providers such as Google, Microsoft and Amazon. As the telecom, internet and media industries are converging it will be very interesting to see how the roles of operators and internet service providers will develop in terms of service provisioning.

## Platform vendor

On the left-hand side of Figure 6 there is the "platform vendor" stakeholder group. Platform vendors are major IT-oriented companies benefitting from substantial economies of scale advantages. They provide generic and standardized hardware and software platform solutions that serve several different industries. Platform vendors supply telecom equipment vendors with basic platform solutions on top of which telecom vendors' own R&D deliverables and sourced products

[6] http://www.nokiasiemensnetworks.com/
[7] http://www.huawei.com/
[8] http://www.alcatel-lucent.com/

(software and hardware components) are integrated. The solutions platform vendors provide constitute mainly of e.g. servers, databases, middleware and operating systems. Platform vendors also provide telecom equipment vendors and operators with ICT infrastructure and related services. Today, platform vendors more increasingly expand to telecom side of the business offering operators business and service layer (see section 2.1.2) OSS/BSS solutions. These solutions may include equipment, software and services related to e.g. billing, revenue management, content delivery and application development and maintenance. In these business areas platform vendors and ISVs are increasingly competing directly with traditional telecom equipment providers. Examples of major platform vendors are HP, SUN Microsystems, Microsoft, Oracle and IBM.

## IP-networking vendor

IP-networking vendors are providing their customers (usually enterprises) with equipment, software and services related to IP-based communication networks. The equipment offered usually includes routers, switches, servers and databases. Software products provide data-networking management capabilities and also useful applications and services (e.g. VPN and web-conferencing solutions) for enterprise customers. IP-networking vendor services may include systems integration (SI), network management and other professional services. Although IP-networking vendors have long been serving only enterprise and institutional customers they are more increasingly able to serve other industry segments as well. For example, many MNOs already have IP-based core networks[9] and these networks mainly constitute of IP-networking vendors' products. IP-networking vendors are essentially considered to be suppliers for major telecom vendors. Usually two kinds of relationships exist between IP-networking vendors and established telecom vendors. IP-vendors may either provide telecom vendors with products that are parts of larger solutions or complementary products that complement the solution and utilize established network vendors' distribution power (Icegate, 2007). These relationships traditionally begin with supply agreements and eventually turn into partnerships, joint ventures, or acquisitions by telecom vendors. One example of similar evolution is a joint venture between Nokia Siemens Networks and Juniper Networks to address global carrier Ethernet markets (Nokia Siemens Networks, 2009a). Substantially the largest IP-networking company is considered to be the U.S. based Cisco Systems, Inc[10].

[9] Turning mobile backhauls to IP/Ethernet or IP/MPLS is considered to be a major trend among MNOs at the moment. This industry trend is discussed in more detail in section 4.3.4.
[10] http://www.cisco.com/

## End-user

End-users are customers for operators and service providers. End-users can be divided into two distinct groups – consumers and enterprise customers – representing their need for different services with different service characteristics. Consumers usually demand reliable basic voice communications, messaging and access to internet. Today, also mobile broadband subscriptions are becoming more popular among consumers. Enterprise customers on the other hand may have a focus on mobility, security and conferencing services when choosing service providers and access operators.

## Standards, regulations, Independent Software Vendors (ISV) and hardware vendors

Left out from Figure 6 are standardization bodies, governments and regulators who have also rather intensive impact on the telecom ecosystem and its future development. Governments and regulators set out regulations on a national and international scope. The international radio resource usage is controlled and regulated by ITU-R but national regulation is set in each country independently. Standardization bodies and consortiums such as 3GPP, IEEE and ATCA (Advanced Telecommunications Computing Architecture) alongside with vendors and operators are driving evolution of mobile broadband technologies.

Similarly, left out from Figure 6 are hardware and software vendors. Hardware and software suppliers are supplying parts and functional software modules or complete software solutions for established network vendors. In this context the definition hardware constitutes of physical products that complement the solution offerings by telecom vendors. These products can be masts, antennas, shelters and fences. Suppliers of Commercial Off-The-Shelf (COTS) components such as circuit boards and chips and standardized software modules (e.g. protocol stacks) are also considered here to belong to the hardware and software supplier group. Telecom vendors' software suppliers provide tailored, functional software that run on different hardware and operating system platforms. These software solutions are integrated to existing solutions and tested for compatibility and functioning by the telecom vendor. These software vendors are usually called Independent Software Vendors of ISVs. Examples of major telecom-oriented ISVs are Telcordia and Amdocs.

### 2.2.2 Changing value configurations

## Value chain

If the traditional value creation logic of Michael Porter's value chain (Porter, 1985) is considered, it can be observed that although the value creation in network infrastructure business followed the model a decade ago, the applicability of traditional value chain is weakening in today's telecom equipment markets. Porter's value chain model creates value through a two-level activity hierarchy. The value chain configuration includes primary activities that have a direct link to value creation and delivering it to the customer, while supporting activities help improving the primary activities. The primary activities are inbound logistics, operations, outbound logistics, marketing and sales, and services. Support activities are firm infrastructure, human resource management, technology development, and procurement. Figure 7 presents the general view of Porter's value chain and related activities.

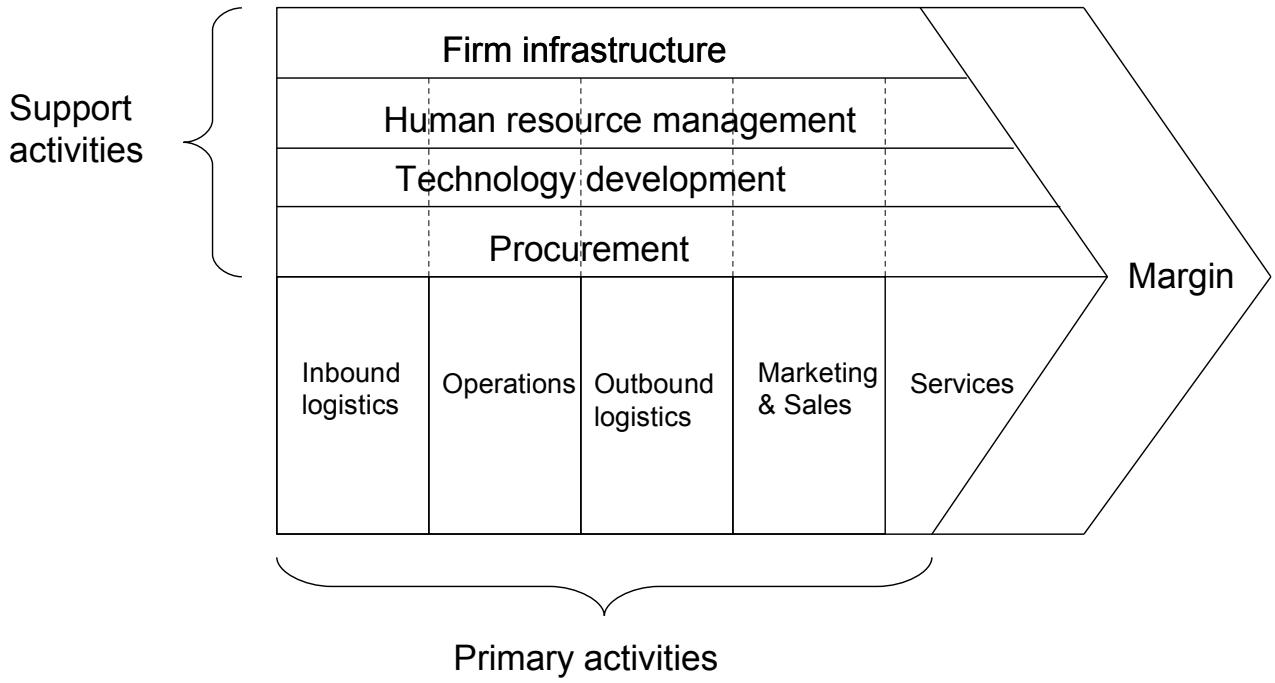


Figure 7: The generic value chain by Porter (1985)

During the past years a clear shift in the value chain configuration's two-level activity taxonomy, especially in the primary activities, can be observed. Today's mobile infrastructure markets are very different. Operators, especially in developed markets, already possess a lot of infrastructure and telecom vendors' focus is turned to other sales opportunities such as professional services and software up-sell. Considering the five primary activities of Porter's model, the market has seen a remarkable shift from the first four activities to the last two of the activities – sales and marketing,

and services. The power position of hardware is weakening while the software and services business is growing rapidly. The value realized by the customer is not derived completely alone from the hardware anymore, but the value of today's market resides in solutions and services. According to a study of telecom operator's business needs during the following three years (BNS, 2009) the main goals of operators today are to increase end-user service experience, lower the high operating costs (OPEX), and to identify new revenue streams. These pain points are driving the network infrastructure vendors to offer managed services deals consisting of operations, administration, and maintenance services of the operator network to lower the operator OPEX, network availability, and service quality. This is why the first three of the Porter's primary activities of logistics and manufacturing are losing relative importance as a company core competence in comparison to the sales, marketing and service activities.

## Value shops and networks

Today's infrastructure business is shifting from large scale system roll-outs to more software and service driven business models. As the nature of business models is changing, the value chain framework has a number of shortcomings. For example, the value creation logic and related activities are less suitable for service driven businesses, thus it is rather difficult to assign and analyze these activities in terms of the five primary value chain categories. These shortcomings *propose that value chain analysis needs to be transformed into value configuration analysis,* which better match with today's service-driven industry (Stabell and Fjeldstadt, 1998). Similar findings are presented by Peppard and Rylander (2006) in MNO internal changing value configuration logics.

Stabell and Fjeldstadt (1998) introduces an extension to Porter's traditional value chain analysis model by introducing an idea of three distinct generic value configuration models – chain, shop, and network. The new models are created on the base of typology by Thompson (2003) from 1967 of long-linked, intensive, and mediating technologies, describing the technology used in the value configuration setting to create and deliver the intended value to the customer. The long-linked technology describes the conventional value creation logic of Porter's value chain by turning inputs into products to create value. The intensive technology describes value creation logic by solving unique customer problems. The resources and capacity needed to solve these custom problems are varying case by case on the contrary of long-linked technology, where the resource needs are known at the beginning of the manufacturing process. The third value creation technology is mediating technology, which enables value creation through direct and indirect exchanges between

customers in the value creation setting. The fundamental idea of the mediating technology is the utilization of positive effect of network externalities, meaning that the value of a product or service is increasing as more users of these services join the value network.

When today's mobile infrastructure business is considered the weight has shifted from chain to shop and network in terms of value creation logic. However, all the value creation logics are still realized being used within mobile infrastructure business. If the physical part of mobile infrastructure is considered telecom vendors source supplies, manufacture and deliver equipment to operators utilizing long-linked technologies. On the other hand, professional service business such as network planning, implementation, project management, consulting and systems integration aims to solve a specific customer problem utilizing intensive technology. Finally, as telecom vendors increasingly provide managed services such as network operations outsourcing for MNOs they are more intensively taking part to the actual mobile services value network utilizing mediating technology.

### Business roles

Ballon et al. (2008) describes a methodology or a set of frameworks (originally based on Faber et al. (2003), revised by Ballon (2007)) to examine business models in terms of shifts in power between a set of abstracted entities. These entities are roles, actors and stakeholders. Ballon et al. (2008) describe a business role as a discrete set of responsibilities, actions, activities and authorizations that together have a coherent value-adding logic. Business actor is described as a marketplace entity that encapsulates a coherent set of roles and a stakeholder is a current real-life organization (a specific individual, institution, company, organization, etc.) with an interest or stake in the outcome of a certain action.

Based on the definition of business role by Ballon et al. (2008) it could be considered that value adding activities introduced by Porter (1985) in value chain analysis are represented by these business roles. During the scenario construction process in the thesis a similar methodology of business actors and roles are utilized to present possible value systems in each future scenario.

## *2.3 Telecom software*

Since the days when semiconductors and silicon chips began to evolve in the beginning of 1990 communications networks have started to transform from voice-centric to data-centric networks little by little. It all started with modems that were implemented to integrate personal computers to traditional circuit switched voice networks. Until that time most of the telecom equipment was

hardware dominant in terms of differentiation and functionality. With the emergence of 2nd generation mobile technologies and wireless computer networking the functional power has shifted from hardware to software. Today's communications networks are mostly made out of IT industry building blocks consisting of routers, data servers and storages, i.e. computers and Internet Protocol (IP) based communications. The traffic in transport, aggregation and core parts of the networks are nowadays to most extent IP traffic. The same evolution can be observed increasingly in radio access where the latest "pre-4G" (e.g. LTE and WiMAX) mobile technologies provide air interface based on IP. The last resort for telecom world, especially the telecom vendors, is the mobile communications networks where the grasp of IT and software vendor has not yet fully reached. Figure 8 below illustrates the "push" IT world (ISVs, major hardware and software platform and IP-networking vendors) is creating towards the telecom industry[11] (the font size describing different industry stakeholders roughly illustrates the market share of each stakeholder in relation to others row-wise).

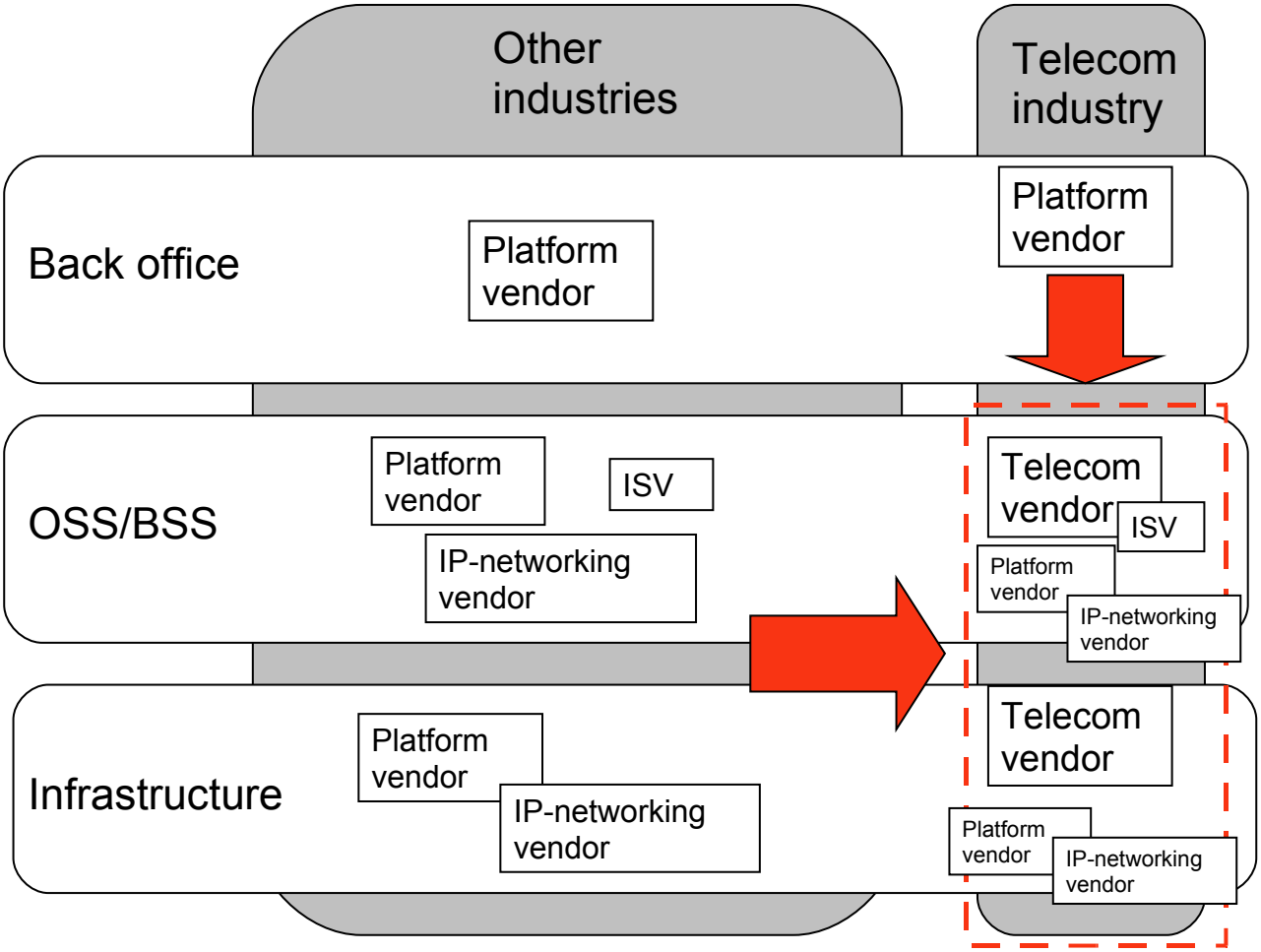


Figure 8: The views of telecom and IT software industries

[11] The illustration is based on industry experts' view of the telecom software markets.

The rows illustrate three areas of the software-related businesses – Back office describes the business management software and systems such as ERP and CRM, OSS/BSS row represents the infrastructure and service management solutions (see section 2.1.2) and infrastructure row represents the physical elements of the underlying infrastructure. For telecom industry infrastructure represents mobile network infrastructure and for other industries it represents enterprise IT and networking infrastructure such as routers, WLAN and/or LAN infrastructure, and leased operator lines.

The large column labeled as "Other industries" in Figure 8 visualizes the horizontalisation of software markets as economies of scale advantages possessed by major IT platform providers offering generic platform and software solutions to variety of industries. Luoma et al. (2008) describes this horizontalisation as a possibility to provide the same software system for 1) two or more customers within the same industry 2) across technologies and 3) across industries. Major platform and IP-networking vendors provide generic ICT and data-networking infrastructure and related management solutions to cross-industry customers. The back-office markets are mainly dominated by platform vendors although more increasingly similar solutions are offered as a service[12].

The situation is different if we look at the telecom vertical in Figure 8. In the back office row there is no change relative to the left-hand column – the same players provide back office solutions and services for telecom operators as to other organizations in other industries. However, the dashed rectangular in Figure 8 represents the "last resort" of telecom vendor software business – the mobile network infrastructure. In mobile networks – especially 2G and 3G – the degree of telecom specificity is still rather high keeping the generic solutions offered by major platform vendors from entering the market. Operators still demand highly specified solutions in order to fulfill carrier grade requirements for latency and network availability even if the costs are high.

Even in the most telecom specific sector - the mobile infrastructure – the base stations and other network components usually are based on platform vendors' hardware platforms. The same can be observed in the OSS/BSS space. This implies that the players from the IT world already are infiltrated in the telecom vertical of the software business receiving their portion of revenues from each network element, e.g. radio base station and network management system sold. Traditional telecom vendors are losing their competitive advantage as standard platform and IP-networking vendor equipment increasingly manages similar communications functions and capabilities than

[12] For example, SalesForce.com (www.salesforce.com) provides enterprises CRM products utilizing Software-as-a-Service (SaaS) business model.

traditional telecom equipment. The trend is that communications network architectures are increasingly turning to all-IP environments in the coming years weakening the strong power position held by telecom vendors at present. There is clear evidence of companies from IT world, such as IBM, SAP, and Oracle preparing themselves by acquisitions and partnerships with more telecom-oriented companies to expand their power over the traditional borderline between IT and telecom businesses. Examples are IBM's acquisition of Micromuse Inc. (IBM, 2006) to broaden IBM's product portfolio with network management software and Oracle's acquisition of MetaSolv Software Inc. (Oracle, 2006) – a leading provider of service fulfillment operations support systems (OSS) solutions for communications service providers. The block arrows in Figure 8 represent the increasing pressure faced by the telecom vendors in the telecom software industry.

## *2.4 Managed services*

One of the hottest topics in discussion of network infrastructure vendors' role in telecom industry at the moment is managed services business. The shift in the nature of networking infrastructure business from large system roll-outs to software and services driven business is materializing through the growth of telecom managed services contracts between telecom vendors and operators. In telecom industry managed services have been present several years in form of Build-Operate-Transfer (BOT) but it is the increasing coverage of services included in the deals and new operator needs today that has impacted the markets so intensively. A similar shift in telecom equipment business models is seen today as was seen in the IT equipment markets several years ago. Large IT players such as IBM and Hewlett-Packard were among the first ones to acknowledge and react to the commoditized nature of pure equipment sales in IT markets. The focus was turned towards the software and services business models which offered far more attractive margins and competitive advantage. The telecom managed services as they exist today are very similar to the IT industry's service contracts.

Managed services is a sub-category of professional services provided by a large variety of technology vendors across different industries. In the telecom domain today, the managed services include consultation and systems integration such as OSS and BSS integration, network planning and optimization, testing, operations-administration-maintenance (OAM), repair and spare parts management, and hosting of applications and services. There exist a lot of expressions describing different functions included in managed services deals, and many vendors have their own terminology for their specific solutions. One widely adopted categorization is to make a division between network-related and IT-related services targeting network layer and service/application

layer of communications infrastructure, respectively. This categorization also roughly describes the two broad vendor domains in managed services markets – vendors providing multi-vendor and multi-technology systems and services in telecom industry (telecom vendors) and vendors providing mainly support services for their own IT infrastructure system deployments (platform and IP-networking vendors).

The main goals of today's operators are to increase subscriber quality of experience (QoE), reduce operational expenditure, and find new sources of revenue (BNS, 2009). The same operator needs drive the development and adoption of managed services provided by technology vendors. In the markets where mobile penetration is exceeding 100% operators are mainly seeking OPEX reduction to maintain profitability under market maturity. Managed services reduce operator's OPEX by outsourcing their network operation, administration and maintenance. The contracts may also include network modernization and optimization in order to reduce network complexity. The growing wireless traffic and need for more bandwidth is driving operators to upgrade their networks or migrate to the next generation networks. This trend is also accelerating the managed services business as operators need the expertise of new technologies and managing the integration of legacy and next generation systems. The telecom managed services that tackle operators' high OPEX mostly represents the network-related proportion of today's managed services markets.

The IT-related side of the telecom services markets will be a fierce battlefield for all vendors including ISVs, platform, telecom and IP-networking vendors. Major platform vendors are expanding to telecom industry following a natural development path as the telecom equipment increasingly begins to converge with traditional IT equipment. On the other side the telecom suppliers are intensively competing for the IT-related services market share as it is one of the few growth opportunities in today's declining network infrastructure markets.

IT services are situated in the application and service domain while the network-related services mostly reside in the network domain. Today's telecom IT services constitute mostly of revenue management, hosted services, service and content delivery, application development and maintenance, and also equipment. Especially in developed markets, where mobile broadband data rates and subscriptions are increasing rapidly, operators are seeking new business models and revenue streams. In this environment, operators are searching partners in media and other industries in order to provide end-users with valuable services rapidly, and avoid becoming sole connectivity providers. Operators should engage in managed services deals offered by vendors in order to improve time-to-market of new service roll-outs. These service layer solutions may include

applications and solutions development, maintenance and hosting services, revenue management services and secure asset exposure solutions and services.

The requirements for emerging two-sided business models are that operators open their networks for third party service and content providers deploying open Service Development Platforms (SDP). Telemanagement Forum (TMF) (TM Forum, 2009) describes an SDP as an *environment or system architecture designed to enable rapid, cost-efficient service creation, deployment, execution, orchestration and management.* SDP is a set of components that provide service delivery architecture for a certain type of service. They may constitute of components and functions such as service creation and execution environments, session control, protocols, third party content and service management, asset exposure, service-oriented architecture (SOA) principles and service orchestration. Today, SDPs are very technology or network centric (vertical solutions) with no common standardization. TMF is one of the strongest stakeholders driving the development of a common SDP standardization. Figure 9 describes a SDP on an abstract level.

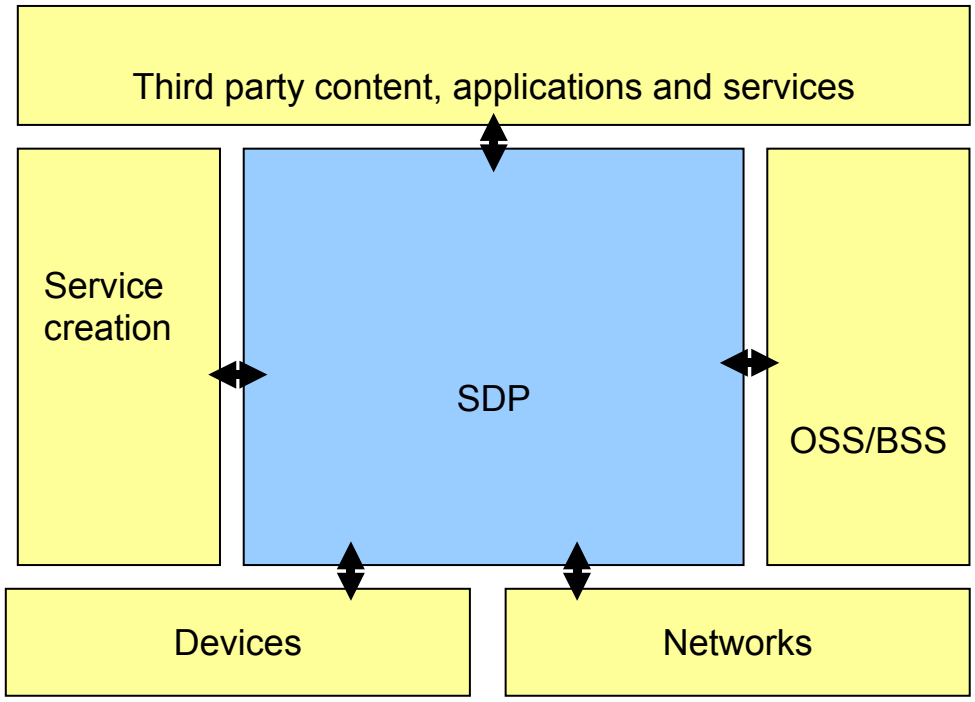


Figure 9: Service Delivery Platform (adapted from Sibbiqui et al. (2008))

## *2.5 Mobile access landscape*

Demand for mobile broadband access is increasing fast. Especially, in developed markets where voice markets are saturating the growth of wireless broadband has increased rapidly. Mölleryd et al. (2009) remark that in several European countries the number of Mobile Broadband (MBB)

subscriptions has shown an annual growth rate of several hundred per cent and in Sweden the number of MBB subscribers will surpass one million during 2009.

The increasingly growing MBB subscriber base and wireless traffic bring challenges to mobile operators. As one of the main challenges faced by mobile operators Mölleryd et al. (2009) introduce the ‘”revenue gap” arguing that mobile data generates 80% of the traffic while only contributing with 2% of the revenues. One of the main reasons given for the data explosion is the diffusion of flat-rate pricing which stagnates the ARPU while networks are congested with traffic. The growing network traffic in this case does not increase the cash-flow for operators and thus new investments are more difficult to make (even though the demand for wireless access is growing among end-users).

Mölleryd et al. (2009) introduces several options for operators to reduce the impact of the revenue gap. One option presented is to share active network infrastructure between operators to reduce both CAPEX and OPEX. Another option introduced was to leverage existing operator assets by utilizing spectrum re-farming to deploy more spectrum-efficient technologies such as WCDMA, HSPA and LTE on spectrum bands currently utilized for older, less efficient technologies such as GSM/EDGE. Offloading traffic from congested macro cells to local area (LA) networks utilizing 3GPP femtocell or Wi-Fi technologies was also introduced as one of the options to tackle the increasing demand of wireless access.

It is yet to be seen how the technological landscape of MBB access will evolve and which technologies will be deployed. Smura and Sorri (2009) have developed scenarios that address the issue of access fragmentation based on two key uncertain dimensions - the verticality of industry structure and the degree of access fragmentation. The vertical industry structure represents a situation where *the services and network access are provided by the same company, and bundled and sold as packages to end customers* while in the horizontal industry structure the services and access are provided separately. The other axis of the matrix is the degree of fragmentation in access markets. In the integrated access scenarios only a few operators provide access to end-users utilizing globally standardized technologies bound to a specific licensed spectrum. On the other extreme, in the fragmented access scenarios, the competition in access markets is fierce as many operators provide access utilizing a variety of technologies for both licensed and license-free access partly due to the actions performed by regulatory bodies in order to promote competition. Figure 10 presents the scenarios constructed by Smura and Sorri (2009) after which brief descriptions of the scenarios are presented.

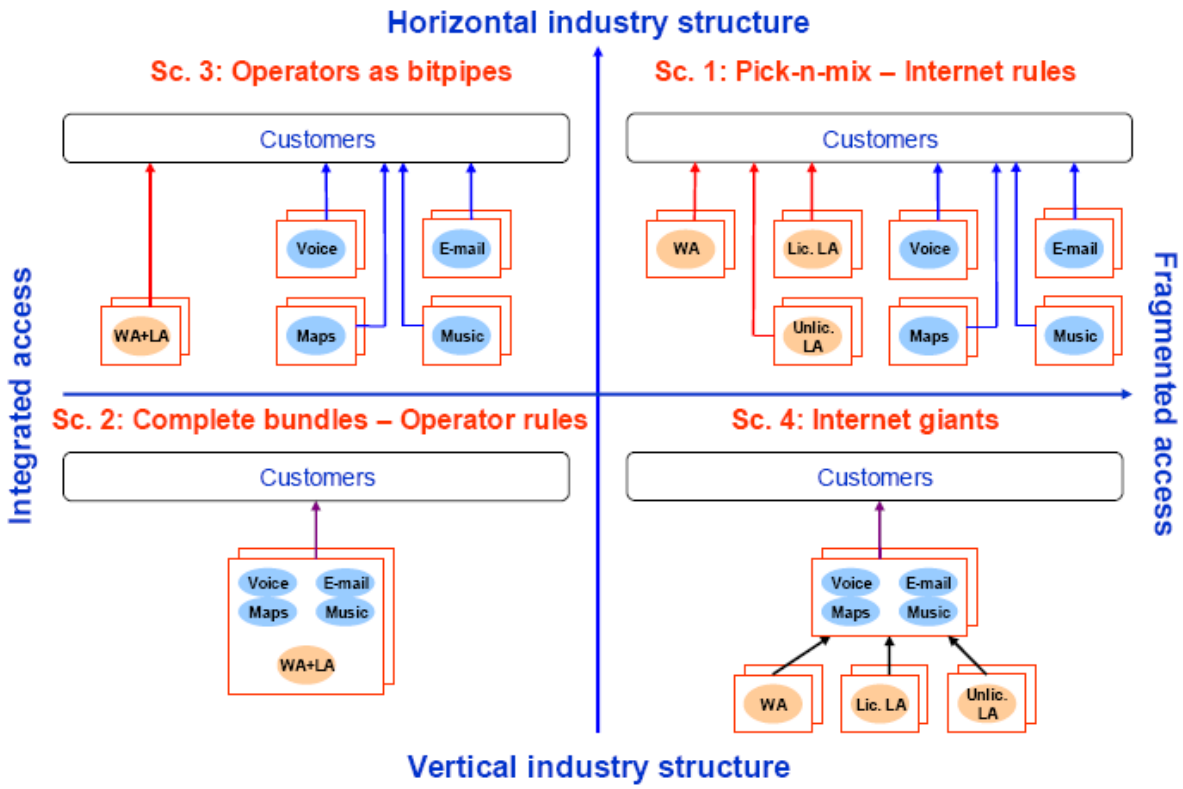


Figure 10: Scenario matrix (Smura and Sorri (2009))

The "pick-and-mix" scenario is a combination of horizontal industry structure and fragmented network access resulting in fierce competition in services and access markets. In this scenario the services are separated from the access but the access to communications services is fragmented in both technology-wise and business-wise. The competition between operators offering access locally is fierce, and no dominant technology is seen in the access network market. Many competing technologies by many access providers are used to provide access. Both 3GPP and IEEE standardized technologies are represented in the access markets utilizing both licensed and license-free spectrum bands.

"Operator rules" scenario is a combination of vertically integrated industry structure and technologically integrated network access. In this scenario the vertically integrated industry structure implies that operators have successfully extended their power position to services business, choosing partners among media and internet players in order to provide end-users complete, bundled service offers, including network access. The network access is integrated technologically implying that the spectrum is controlled centrally and owned by only a few

incumbent operators. These large operators provide access to all subscribers at both local and wide area locations.

In the “Operators as bit-pipes” scenario operators are operating as sole bit-pipes as access and service provision are separated from each other by regulatory actions. Integrated access in the scenario implies that only a few standard access technologies are utilized for public local and wide area access, and the technology is globally standardized and tied to a specific licensed spectrum. End-users will choose access and services separately making contractual agreements with both stakeholder groups separately.

The final scenario “Internet giants” is a combination of vertical industry structure and fragmented access. In this scenario the most powerful position is held by the internet service and content providers such as Google and Microsoft, which have broadened their power position to reach the access and device markets. Incumbent operators have lost their grip over the services and now they face fierce competition in the access markets where many bit-pipes of different technologies exists. Strong vertical presence is possessed by internet moguls who purchase access services from access providers in a wholesale or roaming-based manner in order to deliver content and services for end-users. End-users make contractual agreements directly with these large internet service moguls for access, content and services, and also possibly for devices.

# 3 Theoretical frameworks

In this chapter the research methods and theoretical frameworks utilized in thesis are presented. First the scenario planning method is introduced, especially the Schoemaker's method which is the one used in the thesis. During the description of Schoemaker's scenario planning process some complementary methods and frameworks are also presented. The intend is to present how these complementary methods are used in the thesis and how they relate to the scenario planning process.

## *3.1 Scenario planning*

Scenario planning is essentially a method to prepare for the future and it is mainly used in strategic planning by organizations. There exist many definitions of the method. Schoemaker & Mavaddat (2000) defines scenario planning as *a framework designed to address complex and highly volatile environments by revealing and organizing the underlying uncertainties.* Scenario planning methods of today largely stems from the late 1960s and early 1970s when Royal Dutch/Shell developed a technique called 'Scenario planning' (Wack, 1985) to prepare for the 1973 oil crisis. Royal Dutch/Shell is widely considered as being the pioneer in employing scenarios for strategic planning (Porter, 1985). More recently and in the field of mobile communications industry a variety of studies and researches have been conducted employing different scenario planning techniques. For example, Karlson et al. (2003) constructed scenarios of the mobile industry having a time-scale from 2003 to 2015. Smura and Sorri (2009) studied future local area access scenarios utilizing scenario planning method. Ballon (2004) studied the future scenarios of fourth generation (4G) mobile systems and services in Europe and the defining major trends and uncertainties behind them.

Scenario planning techniques are practical methods for organizations to understand industry uncertainties and possible impacts on future industry structure. They are also useful for company managers to avoid commonly perceived misleading assumptions about the future. For example, Porter (1985) mentions that managers are usually not able to address industry uncertainties very well, they may believe that past will repeat itself, and usually fail to consider or underestimate radical or discontinuous changes impacting the industry. Schoemaker (1995) highlights similar benefits as he argues that by identifying important industry trends and uncertainties shortcomings of overconfidence and tunnel vision can be avoided.

Schoemaker's method of scenario planning is used in the thesis. Schoemaker's scenario planning process constitutes of ten steps (Schoemaker & Mavaddat (2000)). These ten steps are presented in Table 2.

Table 2: Steps in Schoemaker's scenario planning process (originally from Schoemaker & Mavaddat (2000), adapted from Smura and Sorri (2009))

| # | *Step* |
|---|---|
| 1 | Define the issues you wish to understand better in terms of time frame, scope, and decision variables. |
| 2 | Identify the major stakeholders or actors who would have an interest in these issues, and their current roles, interests, and power positions. |
| 3 | Identify and study the main forces that are shaping the future within the scope, covering the social, technological, economic, environmental, and political domains. |
| 4 | Identify trends or predetermined elements that will affect the issues of interest from the list of main forces. |
| 5 | Identify key uncertainties (forces deemed important whose outcomes are not very predictable) from the list of main forces. Examine how they interrelate. |
| 6 | Select the two most important key uncertainties, and cross their outcomes in a matrix. Add suitable outcomes from other key uncertainties, as well as trends and predetermined elements to all scenarios. |
| 7 | Assess the internal consistency and plausibility of the initial scenarios, revise. |
| 8 | Assess how the key stakeholders might behave in the revised scenarios. |
| 9 | See if certain interactions can be formalized in a quantitative model. |
| 10 | Reassess the uncertainty ranges of the main variables of interest, and express more quantitatively how each variable looks under different scenarios. |

The process begins (steps 1 and 2) with the definition of the chosen time-frame, scope, decision variables and key stakeholders who play an important role or have an interest in the issues related within the chosen scope. Slightly diverting from the Schoemaker's process, between the steps 2 and 3 the current industry structure is studied utilizing a five-force framework by Porter (1980) (see section 3.3). In steps from 3 to 5 the market forces that may have an impact on future within the scope are studied. During the step 3 the PEST framework (see section 3.2) is utilized to categorize the collected market forces. In steps 4 and 5, based on the importance and probability the main trends and uncertainties from the list of main forces are selected. During these steps a series of expert interviews was conducted in order to assess initially selected most important trends and uncertainties. In steps 6 and 7 the two most important key uncertainties are selected to form a matrix of four boundary scenarios. Elements of key trends and other key uncertainties are then added to resulted scenarios. Scenarios are presented utilizing a methodology involving business roles and actors (see section 2.2.2) in order to illustrate possible value systems of each scenario. In step 8 the behavior of key stakeholders are assessed. In the thesis this step concentrates on defining strategic implications for telecom vendor stakeholder group. The strategic implications are discussed based on the strategy frameworks under industry uncertainty by Porter (1985) (see section

3.3). The last two steps involve quantitative analysis which is not conducted in the thesis and left for future research.

The scenarios constructed in the thesis are partly based on local access scenario study by Smura and Sorri (2009). To some extend similar matrix dimensions were used as a basis and bounding limits for the thesis scenarios (see section 4.4.1).

## *3.2 PEST framework*

PEST analysis is a framework for analyzing macro level environmental forces affecting businesses and markets in the selected industry. Macro-level study of the environmental forces is very useful when a current situation or possible future directions of industry evolution possibilities are to be understood. The PEST acronym is derived from the categories that are used to classify macro-level forces. These categories are political, economical, sociological, and technological factors. Sometimes the original PEST acronym is accompanied with factors such as legal, environmental, educational and demographic factors to form a variety of different phrases such as PESTEL, STEEPLE and STEEPLED.

Mobile communications industry ecosystem involves important stakeholders representing a source of important market forces from each PEST category. Political or more importantly regulatory actions (e.g. spectrum regulation) are critical determinants for the entire mobile industry. Economical and business factors are substantial as incumbent operators have invested substantial amounts on mobile infrastructure and spectrum licenses, and are doing everything they can to protect their investments while new entrants utilizing disruptive technologies and business models keep emerging in the industry. End-users drive the market in terms of which services, content and applications add the most value and thus generate the most revenues. Increasing mobile data traffic forces operators and telecom vendors to develop and deploy technologies to cope with increasing traffic and stagnated or decreasing ARPU. The usage of PEST model to gather most important forces during the third step of Schoemaker's method (see section 3.1) will provide a broad view of forces and their sources shaping the future mobile communications industry scenarios.

## *3.3 Porter's frameworks*

A number or theoretical frameworks introduced by Porter are utilized in the thesis. The selected frameworks for the thesis are presented briefly below.

### 3.3.1 The five-forces framework

The Porter's five competitive forces is a widely adopted framework to conduct a structural analysis of different industries. It is an essential tool for organizations trying to understand competition in the industry and developing competitive strategies. According to Porter, understanding industry attractiveness and possible opportunities for competitive positioning within an industry creates the basis for competitive strategy development. The Porter's five forces are used to elaborate and study the industry attractiveness in order to assess organization's opportunities of profitability. The forces are depicted in Figure 11 and they are the entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers, and the rivalry among the existing competitors.

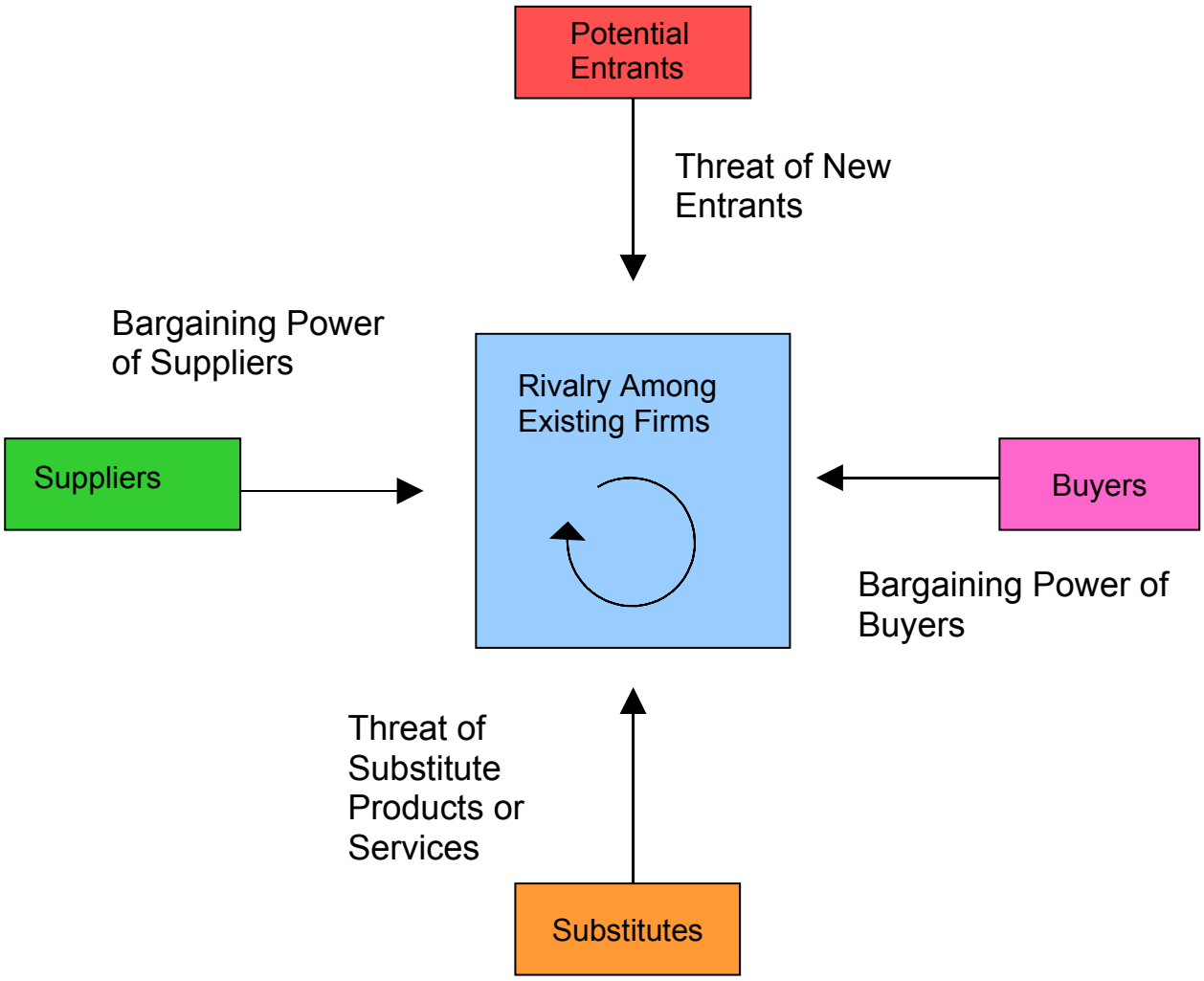


Figure 11: The five competitive forces by Porter (1980).

The five-force framework is used to assess the current industry structure and possible shifts in each constructed future scenario and compare them to the current industry structure and competitive

environment in order to create a basis for competitive strategy creation for telecom vendor stakeholder group.

### 3.3.2 Strategies under uncertainty

A combination of scenario planning and strategy creation is a powerful tool for strategic planning. According to Porter (1985) by constructing multiple scenarios, a firm can systematically explore the possible consequences of uncertain elements for its choice of strategies. Porter's model of scenario planning under industry uncertainties involves a step of systematic competitive strategy creation based on constructed industry scenarios. The fundamental idea here is to consider the most beneficial ways to cope with industry uncertainties. As a starting point the initial industry structure, the resources possessed by a firm and the firm's positioning in the business ecosystem should be taken into consideration. The selection of competitive strategy involves constant balancing and trade-offs considerations between risk-taking and cost evaluation. Porter introduces five generic approaches for competitive strategy under uncertainty and also important criteria behind the selection and combining of different strategies. The application of Porter's framework is slightly different in the thesis as strategic implications and recommendations are made for an industry stakeholder group instead of a single industry player.

#### The basic approaches

The five basic approaches in terms of competitive strategy under uncertainty introduced by Porter (1985) are presented below.

*Bet on the most probable scenario.* The fundamental idea of this strategy is quite self-explanatory. Here a firm evaluates the scenarios and chooses the one (or a set of scenarios) which is expected to have the highest probability of occurrence among the constructed scenarios. Formulating strategy based on this approach an organization must consider aspects of scenario probability, the consequences of adversity, and the width of the resource gap between the initial industry structure and the one(s) in the chosen scenario(s).

*Bet on the best scenario.* This approach is also extremely determined as is the first alternative strategy approach. Instead of preparing for the most probable scenario here the organization will prepare for the most feasible scenario where it possess the most sustainable long-term competitive advantage, even though the occurrence of the scenario might be unlikely. When selecting this strategy it is important to assess the scenarios in terms of the organization's positioning in each

scenario and find a lining in initial and future competitive advantage, where the smallest resource gap exists.

*Hedge.* The hedge strategy is wider approach compared to the first two approaches. The fundamental idea is to generate a strategy which will produce satisfactory results in each of the scenarios, or at least in the most probable ones. The most notable defect here is the weakened competitive advantage in the realized scenario compared to competitors. Other remarkable shortcoming of this strategy is the high costs if the organization chooses to invest heavily in many parallel strategic approaches. When choosing *hedge* as a strategy the organization must consider the probabilities of each scenario above other measures.

*Preserve flexibility.* The fourth basic strategy is another "robust" approach similar to the hedge strategy. With this approach the organization postpones its resource commitments until there are more concrete signs about the outcome of industry structure. The most important benefit of this approach is to mitigate the risk of going in wrong direction. The lowered risk, however, comes with the expense of deteriorated first-mover advantages. When choosing flexible strategy it would be beneficial to try to specify future key "checkpoints" that influence the course of industry evolution most intensively.

*Influence.* The final approach is different from the previous ones in terms of the actions taken by the organization or stakeholder group to impact the direction of industry evolution. In the four previous strategies the organization basically chooses its approach and awaits for the outcome of the industry evolution (apart from the preservation strategy). However, when adapting to the influence strategy the organization takes actions to be involved in shaping the causal factors that determine the future scenarios, e.g. technological change and governmental policy and regulation. If influence approach is chosen the organization must consider its possibilities to affect the determining factors behind scenarios, and to weigh the cost of influence and gained benefits in case of success.

## Criteria for strategy selection

Porter introduces five important criteria which should be taken into consideration when an organization chooses its competitive strategy under industry uncertainty. As a general guideline it is advised that conscious and informed decisions about strategy are preferred over inertia and implicitness. Porter points out that the most challenging part of coping with uncertainty is to minimize costs of hedging and preserving flexibility, and maximizing the advantages of a correct bet for the future. Porter also implies that a good starting point is study the contributions of each

value creation activity to company's competitive advantage under each scenario. Below are briefly described the five important criteria for choosing competitive strategy under uncertainty.

*First-mover advantages* such as preempting a position and switching costs are to be evaluated when competitive strategy is being chosen. Organizations must consider the balance between first-mover advantages and preserving flexibility.

*Initial competitive position* of an organization is an important starting point for strategy planning. Organizations should consider the alignment of initial market positioning and positions in different scenarios, especially in the "best" and most probable scenarios.

*Cost or resources required.* Different competitive strategies under industry uncertainty have different costs and require different amount of company resources. For example, preparing for more than one scenario or trying to influence the scenario probabilities usually costs more and requires more resources than other approaches.

*Risk* is an obvious factor in future strategy planning, especially in industries where great uncertainty is present. Risk is multidimensional in nature and it is composed of many factors. A number of key contributors to risk introduced are timing of resource commitment, strategy inconsistencies, scenario probabilities, and the cost of changing strategy.

*Competitors' expected choices.* One critical source of preliminary information for strategic planning is competitive intelligence. Knowledge of competitors' recent strategic choices or expected future choices gives invaluable guidance for organization's strategic planners under uncertainty. For example, if an organization's rivals choose to hedge or preserve flexibility, there are greater benefits for the organization in terms of competitive advantage if it manages to bet correctly.

These selection criteria for strategic planning under uncertainty are utilized in the thesis as strategic approaches for telecom vendor stakeholder group are analyzed.

## *3.4 Interviews*

Interview is a prearranged interactive conversation where the interviewer asks the interviewee questions. The fundamental idea behind interviewing is to gather information via verbal interaction. Interviews are usually divided into classes based on the degree to which prearranged interview questions control and steer the interview (Preece et al., 2002). Hirsijärvi and Hurme (2001) divide interviews into three different classes; 1) open, un-structured, 2) open-ended, semi-structured and 3)

closed-end, structured interviews. The open, un-structured interview is rather informal where a common subject of interest is determined and conversation may progress freely to any direction. Similarly, open-ended, semi-structured interview involves informal conversation about the selected topics but it also involves a number of predetermined questions. Closed-end, structured interviews are most formal ones where all the interviewees are asked the same questions in predetermined order.

In the thesis a combination of open and semi-structured interviews is utilized. For each interview session a topic is selected that represents the interviewee's know-how and area of expertise. In addition a number of predetermined questions are presented to the interviewees. Most of the interviews were conducted in face to face manner and involved only two participants (i.e. the interviewer and interviewee) but some interviews were conducted via a teleconference line and few interview sessions involved two interviewees. Interviews took place during the steps 4 and 5 of Schoemaker's scenario planning method (see section 3.1) in order to assess the key trends and uncertainties.

# 4 Scenario construction

In this chapter mobile communications industry scenarios are constructed utilizing Schoemaker's scenario planning process (see section 3.4). The section begins with a discussion of the current structure of telecom equipment industry. After that the market forces impacting the business ecosystem are gathered and categorized according to the PEST model. Then, initial assumptions are made regarding the importance and uncertainty of the forces after which a series of open interviews with industry experts is conducted in order to assess the initially chosen industry trends and uncertainties. Finally, possible future scenarios of mobile communications industry are constructed presenting the possible value systems in each scenario.

## *4.1 Time frame, scope and stakeholders*

The key stakeholders involved in scenarios are telecom vendors, MNOs, WIAPs, service providers, end-users, platform vendors and IP-networking vendors. The value configuration (see section 2.2, Figure 6) and descriptions (see section 2.2.1) of these stakeholders were presented previously in the thesis. The scope was chosen to be the mobile communications industry having a weight on the strategic fit between operators and vendors in possible future scenarios. The time-frame chosen was limited to five years ranging from 2010 to 2015.

## *4.2 Industry structure today*

The current industry structure is described below utilizing the framework of Porter's five competitive forces (see section 3.4.1). Figure 12 illustrates the main determinants of each force impacting the telecom equipment industry structure.

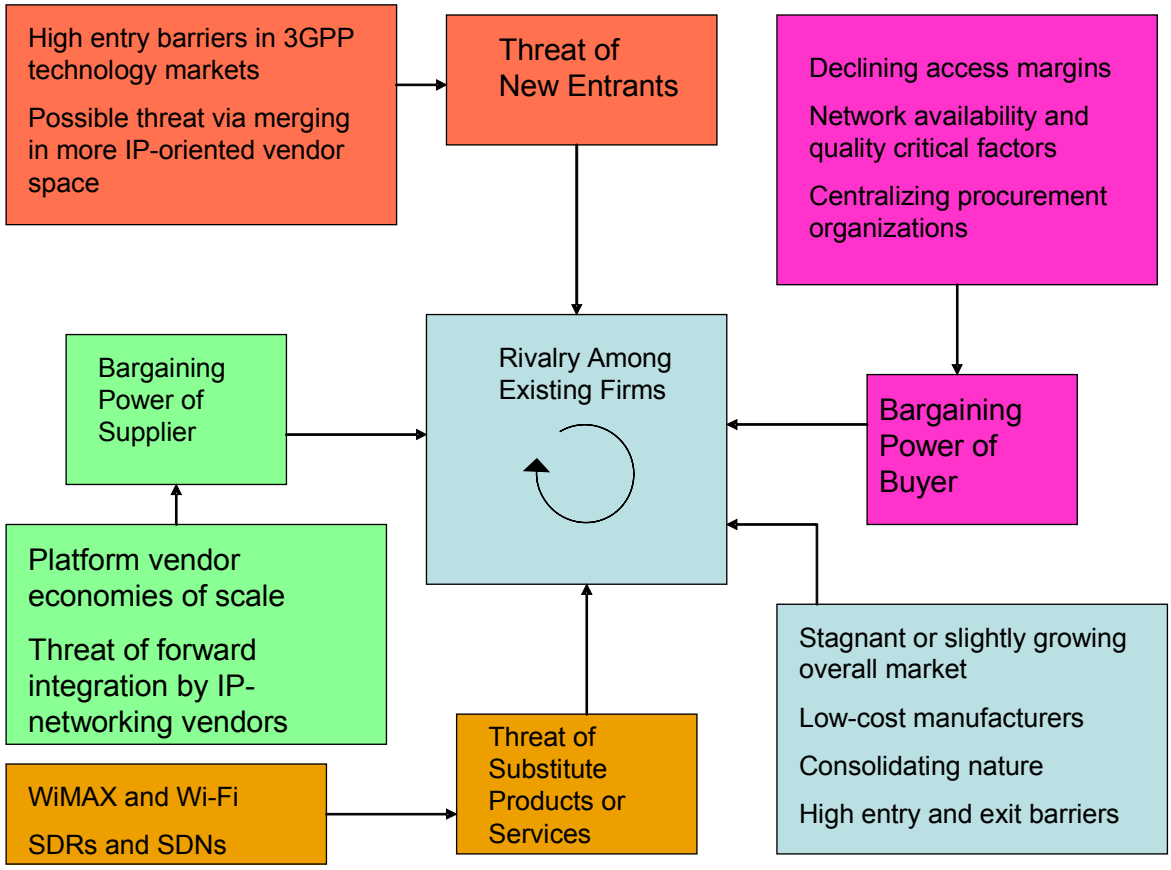


Figure 12: Today's telecom equipment industry structure.

### 4.2.1 Bargaining power of buyers

In today's telecom equipment markets the use of bargaining power of buyers (mainly MNOs) to lower equipment prices is not a chosen option, but rather a sanction driven by buyers' decreasing profits[13]. The main reasons for this are the growing wireless data traffic, declining voice revenues and diffusion of mobile data flat-rate pricing. As the access margins decline the value received from sole equipment, including hardware and related software, is decreasing. The low access margins drive the physical network component prices down forcing equipment vendors to adapt to the business ecosystem and possibly find new sources of revenue from other industries such as energy industry[14].

As said above the price erosion of network equipment is not a chosen option by operators of bargaining the prices down, but rather a sanction. This development of deteriorating access profits is decreasing the bargaining power of buyers. Another key factor lowering the bargaining power of

[13] 'Buyer profits' is mentioned by Porter as one of the determinants of bargaining power of buyers (Porter, 1980).
[14] For example, Nokia Siemens Networks provide energy industry smart grid solutions utilizing existing telecom network management platforms (Nokia Siemens Networks, 2009).

buyers is the fact that network maintenance and operation are still extremely critical aspects[15] of operator business as operator's entire business case is based on network availability and service quality. This lowers buyers' bargaining power and the industry suppliers may raise solution prices if they can keep their promises about quality of products and services.

Despite the factors deteriorating operator power as a buyer group, operators still hold a strong position as network equipment buyers and thus possess strong bargaining power. Porter introduces several determinants for enhanced bargaining power of buyers of which purchase concentration, volume, fraction of costs, and switching costs are the most important in today's telecom equipment industry. The market is experiencing a trend that operators are concentrating their procurement organizations leveraging their bargaining power by choosing suppliers in a more centralized and professional manner. Also, the purchase volumes are remarkable in telecom equipment market in relation to supplier sales, and operators' purchasing costs of network solutions are large in proportion to overall costs. In addition to these aspects, the switching costs of operator swapping a supplier are not a barrier, increasing buyers' bargaining power. Already operators' infrastructure consists of multi-vendor equipment, and established telecom vendors possess the experience and expertise to manage multi-vendor and multi-technology networks.

### 4.2.2 Rivalry among the existing competitors

The rivalry among the existing large, established telecom vendors is fierce. Already some of the players have exited the market. One example is Nortel Networks filing for a bankruptcy in 2009. There have been some indications that the future won't hold place for all of today's established vendors. The mergers of Alcatel and Lucent, and Nokia networks and Siemens communications have also indicated the pressure prevailing in the network equipment market during the past years. The declining profitability has been driven mainly by the shrinking of overall market[16] during the past few years, hitting the bottom in the end of 2009. The shift has put in motion large-scale employer notices and strict cost cutting programs within many industry players' internal business units.

Great disturbance to industry structure and intensive competition is brought by low cost telecom infrastructure vendors from China with high strategic stakes for global acknowledgement and credibility. These agile players, primarily Huawei and ZTE have influenced the industry through

[15] "Impact on quality and/or performance" is mentioned by Porter as one of the determinants of buyer power (Porter, 1980)

[16] (Porter, 1980) Industry growth is one of the key determinants of the intensity of rivalry among the existing competitors.

increasing the competition between existing industry players. Along with declining access margins low cost players have influenced the increasing price erosion of hardware in network equipment empowering the shift of the focus from hardware to software and services in network infrastructure business. The industry has not yet seen an intensive price competition set in motion by low cost vendors, but it is possible that the industry's nature may turn into a price war, at which every stakeholder would be worse off.

The intensity of the rivalry is accelerated by the current combination and characteristics of entry and exit barriers. The entry barriers are high and difficult to overcome as end-to-end solutions (experience and expertise of complex multi-vendor environment) still holds great value for buyers. At the same time the exit barriers in the industry are high because of the large mergers in which great fixed costs have sunk, strategic interrelationships with suppliers and buyers, and also emotional barriers of long organization histories. The industry is experiencing a situation where there are no new entrants and no leavers, leaving the entire industry with weakened profitability and attractiveness.

### 4.2.3 Entry of new competitors

Entry barriers of entering the mobile infrastructure industry are relatively high as mentioned above. When large, established telecom vendors are considered, their most powerful position against new entrants is the strong experience of networking technologies and complex, multi-vendor systems. When operators are searching for a partner who can deliver and support deployments of highly complex systems, the value which is received by the buyer comes from the vendor's expertise of technology and earlier relationships with buyers. This source of competitive advantage is difficult to gain by possible new entrants in today's industry. However, the industry trends and future visions are implying that the "end-to-end" expertise of network vendors may lose some of its power in the future. The main drivers for this are the trend that software and hardware are decoupling at increasing pace, creating standardized interfaces between hardware and software platforms, middleware and application software, enabling markets for software defined radios (SDR) and networks (SDN) thus enabling true network virtualization. It is yet uncertain how the standardization of interfaces between network elements and management systems (OSS) solutions will come about, but should it be that network hardware adopt the role of a sole "plug" in the networks and networks could be deployed and managed independently by players with no core competence in complex multi-vendor systems, the telecom industry structure would be very different than of today's.

Despite the trends mentioned above that drive the deterioration of entry barriers, today's entry barriers are high as a result of a number of key aspects. The tangible and intangible assets of established competitors in forms of know-how and company infrastructure tend to scare new possible entrants. One particularly strong source of advantage the established stakeholders have is the current and future managed services contracts with today's operators. These services contracts bind operators to vendors for several years (approximately 5 to 7 years on average) in terms of service and even equipment, which makes it more difficult for new entrants to acquire customers and enter the market.

### 4.2.4 Bargaining power of suppliers

The bargaining power of suppliers remains rather low in today's telecom equipment industry, although it has been strengthening over the past years and will strengthen more in the future. The suppliers of large, established network vendors consist of a variety of players such as hardware and software platform vendors, tailored hardware and software vendors, and third party services vendors such as assembly, integration, and consultation service providers. These suppliers also have direct linkages to the operators. As networks become more heterogeneous and all-IP, these vendors will have increased opportunity to grow their direct business with operators bypassing established vendors within the industry and strengthening their bargaining power by increasing the threat of forward integration (=suppliers selling products or services directly to buyers).

The bargaining power of large suppliers is stronger than medium and smaller companies. Large IT and software companies usually serve many companies in multiple industries reducing the meaning of a single industry's buyers thus leveraging the bargaining power (see section 2.3). On the other hand, smaller companies may have only a few buyers who purchase products to complement their own solutions. One example is the situation where established network vendors source the routers and switches included in their mobile backhaul and core network solutions. The bargaining power of these suppliers diminishes even more if the sourced equipment or software is undifferentiated and thus can be purchased from many suppliers. On the other hand, if the supplier's product is highly differentiated to complement the buyer's solution the bargaining power will be increased. In this type of business relationship there is a trend that the supplier is bought by the buyer company or a joint venture is created. This kind of arrangement was recently made by Nokia Siemens Networks and Juniper Networks who established a joint venture to address global carrier Ethernet market (see section 2.1.2).

### 4.2.5 Threat of substitutes

The mobile broadband traffic is growing fast and MNOs may have to explore new ways other than traditional macro 3GPP technologies to support the traffic explosion, especially in densely populated areas and indoor locations. IEEE technologies such as WiMAX and Wi-Fi networks are possible solutions to enhance macro cell coverage and capacity. Vendors such as Motorola, Samsung and Cisco promoting these technologies could become serious threat for the existing telecom vendors currently holding strong positions in the market. However, also 3GPP solutions exist for providing extended coverage and capacity to mobile networks utilizing licensed spectrum. These solutions include spectrum sharing between license owners, spectrum re-farming such as UMTS900 and 3GPP femtocell technologies.

MNOs and telecom vendors should also consider enterprise customer and consumer choices for technology and services to fully understand the threat of substitution. The majority of enterprises and consumers utilize WLAN technologies and VoIP solutions for communications. Adding to this the fact that the majority of wireless traffic is generated in indoor locations, the current substituting technologies with no real mobility support (e.g. WLAN) are already able to provide a variety of services to these customers. Considering the service and technology providers of these solutions (internet service giants, IP-network operators and IP-networking vendors) it can be seen that there is a threat of substitution to the entire traditional telecom value chain.

However, in today's industry there are no credible substitutes for current standardized mobile technologies by 3GPP when mobility is considered. It is speculated that the trend of increased adoption of WiMAX, currently serving niche markets, is expected to compete more seriously with current and future 3GPP infrastructure deployments. The level and credibility of the threat of substitute solutions for mobile infrastructure is driven by the all-IP migration and network modularization and virtualization. If interfaces out from mobile network elements will be standardized the threat of commodity IT equipment such as personal computers to substitute telecom-specific hardware components would be possible. The evolution of mobile technology standardization could possibly introduce SDRs and even SDNs to be adopted widely weakening the power position held by telecom vendors over the 3GPP technologies today.

## 4.3 Identifying the main forces

The study of the forces impacting mobile communications industry having a weight on the strategic fit between operators and vendors started with literature study. Literature study included various company publications, press releases and industry white papers regarding the mobile communications industry, academic articles and books utilizing scenario planning in telecom ecosystem related topics, and other topic-related books as well. Industry news from different portals and channels were also exhaustively followed during the research and information cross-checked for better consistency of the overall industry status and forces driving the change. Industry news stories and articles are useful sources to get insights about the latest topics of the industry evolution especially when the intention is to look into the future of telecom infrastructure markets. When studying these sources it should be noted that they are not academic and quite subjective in nature, though.

When studying the markets from the equipment supply perspective one of the main sources of forces shaping the business environment are the buyers, i.e. operators. Operators and their established technology vendors have a long history of vertically integrated business relationships typical for former telecommunications industry and this legacy is still strongly present in today's industry. Operators and vendors are still heavily dependent on each other and the collaboration between these two stakeholders defines the areas of research and development of technology and new business models. This strong bond is vital to keep in mind when studying the industry forces that most intensively affect the mobile communications market in the equipment supply side. As telecom vendors provide value added solutions for operators, operators' present and future needs and pain-points are one of the main sources of forces-study under the thesis scope.

The main trends and uncertainties in the market are derived from the current challenges and opportunities faced by the operators. The majority of the key forces driving the market from the telecom vendor point of view are technological, obviously, but also many of them are economical considering the current nature of business transformations going on in the vendor and especially operator market. Regulatory and social forces also play an important role in forces study but their impact is not as direct and intense as technological and economic forces.

Below the industry forces are discussed utilizing a PEST categorization. Figure 13 shows the most important forces gathered and categorized according to PEST model. The forces presented in Figure 13 will be discussed during the following sections.

| Political/regulatory | Economical/business |
|---|---|
| • Spectrum re-farming de-regulation<br>• Network sharing regulation<br>• More spectrum licenses<br>• Open access regulation<br>• License-free band release | • Real-time SDM platforms and applications and billing support (BSS)<br>• SDPs, operators exposing their assets<br>• Search of new revenue streams<br>• IMS re-awakened<br>• Emerging M2M business<br>• OPEX reduction<br>• CAPEX spending taking off<br>• Managed services battle (IT vs. Telecom)<br>• Outsourcing<br>• Network sharing and roaming agreements |
| **Sociological** | **Technological** |
| • Mobile applications<br>• Smartphones, PDAs, e-readers<br>• M2M communications<br>• Wireless data traffic<br>• Privacy and security concerns | • LTE/WiMAX migration<br>• All-IP networks<br>• Ethernet backhaul<br>• Networking technology modularization<br>• Differentiation via software<br>• Capacity and coverage upgrades<br>• Centralizing SDM<br>• Cloud services |

Figure 13: Forces impacting the mobile communications industry.

### 4.3.1 Political / regulatory forces

Political and regulatory industry forces are mostly related to the radio spectrum regulations and allocations that affect the operator business and technological evolution of communications networks, but also other important areas such as network sharing policies and regulations. These forces have critical impact on networking technology as radio equipment is designed and built to operate on a specified spectrum. This aspect in technology development was critically important especially in the past. However, until recent years equipment manufacturers are offering multi-radio technologies more increasingly, meaning that one wireless access box (base station or access point) can be modified to operate on several frequencies with software upgrades alone. The basic idea when considering the relationship of technology development and spectrum regulation is that the spectrum regulation drives the technological development and determines the terms of how operators and their vendors can tackle the current and future business challenges and opportunities.

Frequently mentioned spectrum-related topic in telecom industry is spectrum re-farming which basically means that the 850/900 (U.S./Europe) MHz frequency band traditionally allocated for 2G networks such as GSM will be utilized as UMTS networks. The main driver for operators to re-use the older 2G networks is a much more economical way (up to 40% CAPEX and 30% overall cost savings (Ovum, 2007)) to offer higher data rates and better in-door than deploying the traditional UMTS network on 2100 MHz frequency band. For example, the Sweden's first 900 MHz WCDMA/HSPA network supplied by Ericsson will be rolled out in 2010 by Swedish operators '3 Scandinavia' (Ericsson, 2010a). There are also challenges involved in spectrum re-farming. The interference of parallel GSM and UMTS networks and the fact that some operators don't own 900 MHz licenses must be taken into account when setting regulations for spectrum re-farming. The regulatory actions impact operator choices of technology deployments and thus affect the timing of next generation network deployments.

The demand for more spectrum is driven by the increasingly growing mobile data traffic. Regulators and governments are under pressure to release more licensed spectrum (core band: 1920-1960 MHz and 2110-2170 MHz, extension band: 2500-2690 MHz) for 3G networks in order to accommodate the wireless traffic growth. According to GSM World approximately 1,2-1,8 GHz of additional spectrum is needed in each national market within the next 12 years to accommodate the increase of mobile data[17]. The technological choices and future network deployments depend on the regulatory decisions to release additional spectrum. Based on the direction pointed by regulators and governments operators and vendors choose whether to invest in enhancing existing 3G networks or migrating to next generation solutions.

Network sharing and roaming agreements are increasing industry trends in telecom markets driven by the operators' increasing need to concentrate on end-user experience and cut down both OPEX and CAPEX. Passive sharing of network infrastructure (sharing of physical elements such as antennas, masts, feeders, real estate sites, shelters and cabinets) is more common and has already been widely used for several years, especially in high growth markets where the main purpose has been network coverage expansion. Regional licensing schemes where mobile licenses are provided to operators on a geographical basis (e.g. in India) also promote the adoption of passive infrastructure sharing. Active infrastructure sharing (sharing of active components such as radio base stations, allocated frequency spectrum and transmission systems) is more complex as it makes operators more or less interdependent and brings along trust issues between competing rivals. The third generic mode of network sharing is roaming agreements where operators keep their own

[17] http://www.gsmworld.com/our-work/public-policy/spectrum/core_and_extention_bands.htm

infrastructure but allow other operator's subscribers to connect to their networks in certain regions. Active network sharing restrictions are applied in variety of ways and differ from each other nationally. Currently there are indications in the industry that these restrictions will be partly removed in order to promote universal access to ICT networks having a clear impact on network equipment business decreasing the overall market size and shifting the focus off of the traditional large-scale system roll-outs.

Yet another very interesting topic for network equipment business is the liberalization of spectrum policy. The net neutrality in terms of spectrum and technology and open, ubiquitous access are frequently mentioned subjects in the discussions of future mobile industry. The regulatory decisions about spectrum and technology decoupling, dynamic spectrum usage and open access have a remarkable impact on the future of network access technology development and equipment business. Another critical issue considering spectrum liberalization is the nature of license-free spectrum usage. Today license-free spectrum is utilized mostly in private access scenarios but it may be possible that in the future these spectrum bands will also be used in accessing public services. Changes in network technology landscape could be tremendous. For example, the public access possibility via license-free bands could put in motion large-scale WiMAX deployments as this technology is able to utilize license-free bands even today.

### 4.3.2 Economical / business forces

Operators' main assets and core competence have long been acknowledged to be the ability to connect users to each other and to different services and applications. In today's industry operators need to leverage their other network assets more efficiently. One of the key assets is the subscriber data. Operators need to leverage this data consisting of subscriber profile, location, services being used, preferences, and state of billing (e.g. prepaid, charging level, etc.). Combining this data with technical network information such as available bandwidth and connection type more targeted and customer centric services and advertising can be tailored and provided to end-users. The ownership of the end-user data is considered to be one of the key advantages of operators in the highly competitive application and services business dominated by internet service players.

These industry drivers imply that the importance of real-time subscriber data management (SDM) platforms and applications combined with BSS solutions will increase during the coming years. The competition in SDM area is inter-industrial having a wide array of large companies from IT and telecom industries such as IBM, Hewlett-Packard, and Nokia Siemens Networks. To tackle the opportunity to leverage the data they own operators are integrating and consolidating their

distributed, siloed data storages of many different types such as home location register (HLR), home subscriber server (HSS) and AAA database (authentication, authorization and accounting). Centralizing these databases is crucial to take full advantage of the existing operator assets. This is also a great opportunity for telecom vendors to leverage the experience of multi-vendor technologies and relationships with incumbent operators when preparing for the increasing competition in SDM and BSS markets mostly dominated by the IT companies.

Another key focus of today's operators is to recognize new revenue streams (BNS, 2009). The fear of large internet players such as Google, Microsoft and Amazon motivates operators to frantically search for ways to cope with today's application-driven market where the basic voice and messaging services are becoming commodity. Operators have many assets they can leverage in order to avoid becoming bit-pipes including technological, informational, and reputational assets. Only the future will show how the operators will be positioned in the mobile services ecosystem.

A lot of discussion turns to service delivery platforms (SDP) when operators' future position is discussed. With a state-of-the-art SDP operators are able to expose their networks and assets to innovative 3rd party service and content producers in order to compete or partner with internet and media players and thus engage to new revenue streams of the application-dominant mobile market such as app-stores, mobile advertising, mobile payments and banking. Operators have a good starting point to become "service enablers" in the future if they are willing to expose their assets to 3rd parties. However, operators should be careful in exposing sensitive subscriber data such as billing status in order to remain trustful partners of customers'. This is also a great opportunity for established network vendors to compete with IT companies and enhance their market position outside the decreasing equipment market by offering operators flexibility and support in finding and adopting new revenue streams and innovative business models. Vendors are getting ready to offer operators solutions they will increasingly demand. For example, Alcatel-Lucent recently launched a comprehensive set of services and applications in order to help operators to open their infrastructure in secured and controlled way for application developers and content providers to offer consumers and enterprises innovative Web 2.0 services (Alcatel-Lucent, 2009). It is yet to be seen which vendor group will better address the needs of today's operators and will operators be successful in the battle against major internet service players.

One interesting aspect of operators embracing open service development is the speculation of the re-awakening of 3G IP Multimedia Subsystem (IMS). Today operators are trying to find ways to deliver customers more innovative and valuable IP-based multimedia services cost-efficiently. New

complex IMS deployments by operators would provide telecom vendors great opportunities to increase equipment and services sales and possibly reach the revenue streams from mobile applications and services through flexible contracts (e.g. revenue sharing) with operators. The trend of opening the closed networks for 3rd parties will increase the OSS/BSS and service-oriented architecture (SOA) integration market in importance and size and gives great competitive advantage for those players with related competence.

A hot topic in the mobile industry at the moment is the emerging machine-to-machine (M2M) communications and opportunities and challenges brought with it. For example, Huawei Technologies promotes that M2M communications will be one of the four most important industry themes during the next decade[18]. M2M communications implies that with the evolution of wireless and mobile networks the communications will be brought beyond human communications bringing a phenomenon of "internet of things" to life, implying that in near future a whole variety of devices and consumer appliances will be wirelessly connected. Operators and vendors are embracing the topic as it opens possibilities for new revenue streams and business opportunities for players in mobile ecosystem of high competition and deteriorating ARPU. For operators more connected devices means more subscriptions and SIM modules backing up the already applied business models. To enable M2M communications a real-time and consolidated subscriber data management system and possibly some new M2M-specific network elements are needed. The possibilities brought by M2M communications are numerous including telehealth, home security and energy management. The question is in what time scope M2M communications will be turned to profitable business cases generating new revenue streams for the mobile industry stakeholders and to which players' pockets the money will flow.

One of the major goals of today's operators is to cut down operating expenditures (BNS, 2009). Wireless data traffic growth is impacting the mobile operators intensively. Network resources are exhausted and operational costs increase in-line with the traffic growth. However, revenues gained from the data traffic are very low in proportion to the total revenues creating a "revenue gap" (see section 2.5). Operators must decouple exponentially growing traffic and operational costs and are clearly concentrating more on lowering OPEX than reducing CAPEX. Operator CAPEX, however, is expected to grow at least in 2011 after a forecasted flat market in 2010 as financial downturn is easing off and mobile data growth is promoting next generation network deployments in developed markets and 3G deployments in emerging markets.

[18] http://www.huawei.com/innovations/industry_trend_2010.do

One of the biggest industry trends is the network-related activities outsourcing by operators to reduce operational expenditures radically and to concentrate on operator core business. Outsourcing network operations, administration and maintenance through managed services is increasingly growing trend in the industry and a great win-win opportunity for both operators and their vendors. Managed services market is one of the biggest opportunities for telecom vendors to increase profitability in flat or slow-growth market environment.

As was already discussed in political forces section (see section 4.3.1) one industry trend having a major impact on network equipment business is network infrastructure sharing and roaming agreements. A combination of joint ventures by operators and managed services for outsourcing network operations is an increasing trend in today's industry. In early 2009 Ericsson announced (Ericsson, 2009a) that it will integrate and manage the 3G radio access networks of Mobile Broadband Network Limited (MBNL) – the joint venture between 3 UK and T-Mobile UK. Another major joint network deployment project was announced by Telenor and Tele2 (Telenor, 2009) in April 2009 to establish a joint venture named "Net4Mobility" to build an LTE network in Sweden. Although Huawei has been selected to provide the network infrastructure and consumer modems for Net4Mobility, no vendor has been appointed to take over the operations and maintenance of the network yet. The trend is indicating that more operator joint ventures will be established to deploy new networks, consolidate complementary networks or integrate established networks in the coming years bringing growth opportunities for telecom vendors in terms of equipment and service revenues. Increasing network sharing also promotes the meaning of service and content business as coverage will be decreased as a competitive advantage when shared radio access networks are used.

### 4.3.3 Social forces

Social forces have a substantial impact on mobile services ecosystem as end-users are the sources of revenues and ones driving the development of content creation, services, and network coverage and capacity. From the infrastructure vendor point of view the end-user originated forces are not turned directly into company strategy but rather managed in conjunction with operator objectives indirectly. The major social forces driving the mobile ecosystem today and in the future are the increasing use of smartphones and other devices developed to create, transfer and utilize bandwidth-hungry applications and services, and the increasing concern of privacy and security as wireless data traffic increases.

One of the major topics in today's mobile industry is the application market spear-headed by Apple's App store. In the beginning of 2010 Apple reported (Apple, 2010) that over 3 billion apps have been downloaded from its App store in only 18 months. Apple's popularity among consumers is also promoted by a research by CoolBrands[19] where iPhone, Apple and iPod are holding places in the top four coolest brands in the UK. Content and applications will be the industry drivers within the next years in mobile industry shaping the business models and strategies of operators, content owners and producers, device manufacturers and network equipment suppliers. Interesting point in applications industry is how the stakeholders will turn the success in profitable business case as the majority of and the most popular applications downloaded today are free or generate only a small portion of total application revenues.

It is clear that the global wireless traffic will increase substantially during the next five years. In terms of global wireless traffic growth, emerging markets play a huge role mainly because of the lack of fixed infrastructure, and mobile devices being the first devices for data communications (mainly internet access), bypassing desktop and laptop computers. 3G roll-outs in emerging markets, especially in India and China will increase global wireless traffic substantially. In developed markets the first commercial LTE networks were opened in late 2009 by TeliaSonera in Oslo (Norway) and Stockholm (Sweden) downtown areas and nation-wide LTE coverage plans in both countries have already been announced to commence in 2010 (Teliasonera, 2010). Due to the increased data rates brought by LTE radio technology and the nature of communications possibilities in these networks (portable traffic at first, i.e. laptops, netbooks, USB dongles, etc.) the wireless data traffic is expected to increase exponentially after LTE deployments. One of the most critical aspects to consider is that the majority of wireless data and thus revenues will be generated in indoor locations (Wehmeier (2010), Smura and Sorri (2009)).

Another major driver impacting the exponential wireless traffic growth is the emerging trend of machine-to-machine (M2M) communications. We are continuously seeing more mobile and portable end-user devices with broadband communications capabilities brought to market, including smartphones, PDAs and especially e-readers towards which consumers are showing increasing interest to. Adding passive embedded devices to the wireless scene there might be billions of connected devices in the future. The cellular M2M markets are expected to have a huge growth in the near future, and it is forecasted that the global cellular M2M markets will grow from EUR 11,2 Bn in 2009 to EUR 27,4 Bn in 2013 (Idea, 2009).

[19] http://www.coolbrands.uk.com/

Privacy and security concerns are brought up more frequently in discussions of future mobile communications industry. As more sensitive services such as mobile banking are increasingly provided to customers and the popularity of social networking is indicating no downturn, end-users are putting more weight on security and privacy issues in their daily communications. It seems that not until recently people have become aware of the masses of data they have freely given out to be stored in the major internet service giants' databases (e.g. Google and Facebook). The growing importance of trust is a great starting point for operators to leverage this industry characteristic as operators, especially the incumbent ones, have long been end-users' trusted voice and messaging providers. This is also a great opportunity for established network vendors as they are considered as trusted partners of operators' in a similar manner. Trust issues are not addressed only by consumers but also by enterprises that are looking for trusted partners to enable secure cloud services opening opportunities for operators in both customer domains.

### 4.3.4 Technological forces

As mentioned earlier one of the main goals of today's operators is to reduce operational costs. From the technological point of view there are a lot of opportunities to reduce network OPEX. Network simplifications and upgrades are the most efficient ways to reduce network complexity and thus operating costs in terms of technology. The major trends in the industry are the flat network architecture upgrades with HSPA+ and LTE technologies in 3GPP networks and mobile WiMAX deployments in IEEE networks, mobile backhaul upgrades to IP/MPLS or IP/Ethernet via fiber or microwave and the centralization of network management.

As discussed earlier operator investments are vital to satisfy the ever increasing data traffic and decreasing OPEX and now that the financial downturn is finally showing signs of ending operators are more willing to start investing again, especially in developed markets. However, great uncertainty lies in operators' plans when it comes to migration to the next generation networks (NGN).

The industry trends and market news of recent strongly imply that 3GPP's LTE will be the dominant migration path to fourth generation (4G) mobile technology. Announcements made by some of the largest operators such as Vodafone, China Mobile and Verizon Wireless (Vodafone, 2009) to test LTE networks in 2009 support the LTE's domination globally. In the U.S. the major operator AT&T plans to launch a commercial LTE network in 2011 (Ericsson, 2010b) supplied by Ericsson. However, it is still very uncertain when operators will start to deploy the next generation networks, what technology will be deployed, and what role is adopted by the next generation

networks within the next five years. The strategies in developed and emerging markets are obviously different but emerging markets are following behind and it is yet uncertain how far behind they are when it comes to NGN migration.

When will the mass migration to next generation mobile networks begin? The Nordic region (Norway, Sweden and Finland) is spear-heading the migration as TeliaSonera is planning LTE coverage upgrades in Sweden (25 major cities) and Norway (4 cities) during 2010 and deploying the first trial in Finland in the beginning of 2010. Similarly, Net4Mobility has announced that it will start deploying a nation-wide LTE network in 2010 that will have 99% coverage by 2013. However, in other regions major operators are postponing migration plans or by deploying HSPA or HSPA+ upgrades arguing that LTE won't bring any clear advantages over HSPA+ at present and in the near future. For example, Scandinavia 3's HSPA network upgrades in Denmark and Sweden (Ericsson, 2010c) will boost the wireless downlink capacity to 84 Mbps per cell which is very close to LTE's currently promised downlink rate of 100 Mbps. In addition no-one knows how rapid the development and success of mobile broadband with 3G in emerging markets will be. It is possible that 3G deployments in India and China within the next few years accelerate wireless data traffic exponentially and NGN migrations will be needed much earlier than expected. Drivers decelerating the NGN migration include lack of mobile LTE (and other "pre-4G") devices, spectrum constraints, and lack of basic voice and messaging support at the moment. Drivers promoting NGN deployments include the need for more efficient air interface utilization, cost and operational efficiency and lower latency. The success of NGN migrations will not follow their capabilities if faster data rates and functionality are failed to be utilized efficiently enough in terms of new innovative applications and services.

Another uncertainty having an intensive impact on network equipment business is the NGN technology. As said earlier many industry signs suggest that 3GPP's LTE will be the dominant "pre-4G" mobile technology but there are industry stakeholders who believe that other strong possibilities exists. IEEE's Mobile WiMAX is considered to be the most promising direct competitor to 3GPP's LTE. Both parties – 3GPP and IEEE – met the ITU-R deadline to submit proposals to meet the requirements of IMT-Advanced (usually referred as 4G), 3GPP with its LTE-Advanced[20] and IEEE with its Mobile WiMAX release 2 (802.16m)[21]. Feedback about their adequacy will probably be received in late 2010. In the meantime both standards compete for dominance LTE having a clear lead but WiMAX still somewhat strongly present in the industry

[20] http://www.3gpp.org/LTE-Advanced
[21] http://www.ieee802.org/16/tgm/

driven by few large operators as Clearwire in U.S., Yota in Russia, UQ Communications in Japan and Tata in India. Critical times for the future of WiMAX will be seen within few years as WiMAX operators will make the migration choice between WiMAX and LTE.

The role of the NGN technology is also yet to be discovered. The first commercial deployments of LTE networks in Stockholm and Oslo by TeliaSonera are aimed for pure data usage in downtown areas in both cities, and user devices support only laptops with Samsung USB modems that support LTE-only communications (no interoperability between HSPA networks, for example) at the moment. It is yet to be seen whether the NGN migrations will be able to offer basic voice and messaging services with efficient enough QoS or will it assume a role of pure wireless data technology within the next five years. The basic voice and messaging market development is mainly driven by the NGN handset availability. LG announced (LG, 2008) the world's first LTE handset modem chip already in late 2008 but massive mobile device roll-outs won't occur until NGN deployments and coverage expands. Although VoIP is widely used to supplement traditional voice services today the quality, availability and mobility of traditional circuit mobile voice are powerful factors of voice communications.

Today's operators, especially in developed markets, own a lot of network infrastructure. Adverse results of expensive spectrum license and infrastructure investments in 3G technology have made operators to focus on leveraging the value of their existing sites and have made them more careful and price-sensitive when it comes to technology investments. Operators are looking for more modular ways to enhance their infrastructure thus impacting technology vendors' R&D activities. The traditional and profitable core asset of operators – the ability to connect users with other users and services – is becoming commodity. The basic hardware to enable this need of today's community is decreasing in value as operators are not able to purchase expensive systems if these systems won't deliver any real value for them. This trend drives the development of modular systems where functionality can be added with modular system upgrades and sometimes via software alone (e.g. SDR) decreasing the role of hardware and accelerating the on-going hardware price erosion. This industry driver is decoupling the hardware and software in sense of both equipment and business models increasing the role of software in product differentiation.

Many standards have emerged in the telecom market to address the traditional telecom hardware and software component, platform and interface design opening possibilities for several suppliers to offer these systems accelerating the commoditization of hardware. Many stakeholders in the industry are pursuing for more open and modular network systems. All-IP migrations with Ethernet

and MPLS backhauls are implying this evolution strongly. In the traditional vendor business area of radio access equipment the transition to multi-radio technologies that are upgradable via software upgrade only (e.g. from HSPA to LTE) and increasing focus towards self-organizing networks (SON) and plug-and-play base stations indicate the development towards more open and flexible solutions. SON-capabilities are exceptionally important if end-user deployable femtocell BS and AP technologies are considered. The industry trend of IMS being re-awakened by established operators also promotes openness with the open Application Programming Interface (openAPI) Session Initiation Protocol (SIP). There are also global organizations and consortiums that promote open and modular communications computing platforms, applications and systems development such as PCI Industrial Computer Manufacturers Group[22] (PICMG) and The Communications Platforms Trade Association[23] (CP-TA). In the OSS/BSS area of telecommunications the standardization is driven by the TM Forum with its Solution Frameworks (NGOSS). System modularization evolves closely in-line with regulatory actions around the degree of coupling of technology and spectrum shaping the evolution of net-neutrality and ubiquitous access.

The shift of the differentiation power from hardware to software has made telecom vendors spend large proportions of their R&D on software development. However, revenues received from software sales (application software, licenses, and software maintenance) in proportion to total revenues are limited. Telecom vendors are forced to pursue business models that differ from the traditional large-scale system roll-outs of the past. Vendors are embracing software and services market as it is seen as one of the key opportunities to grow market share and find new revenue streams in today's market. The competition in this field will be fierce as the existing telecom vendor rivals are battling for services contracts but also platform vendors, ISVs and IP-networking vendors are expanding their businesses from IT-related services to network-related services.

Due to convergence of IT and telecom industries it is not certain that the future will hold places in the market for all of today's telecom equipment vendors forcing some of the rivals exit the industry as a result of a bankruptcy, merger or acquisition. One possibility is that a telecom vendor moves to another position in the mobile industry value system. The price erosion of hardware and its commoditizising nature imply a possibility that a telecom vendor abandons equipment supply business and concentrates fully on services business providing professional services such as consulting and operations outsourcing leveraging the existing multi-vendor technology competence needed to manage and cope with today's complex network infrastructures.

[22] http://www.picmg.org/
[23] http://www.cp-ta.org/

Probably one of the biggest hypes in telecom industry at the moment is the cloud services phenomenon where customers are offered computing power and storage as a service. Cloud is an opportunity for enterprises to reduce IT infrastructure costs and shift from buying products to buying services enabling access to valuable services and applications without the need to purchase expensive hardware, software or licenses. As clouds are discussed intensively in the industry it is vital to involve their impact on telecom vendor business.

Today's telecom industry is experiencing the convergence of IT, telecom and media and every stakeholder group is strictly watching the blurring borders between. The increasing popularity of cloud services promotes the already dominating position of IT and internet players such as IBM, HP, Google and Cisco who are offering operators to improve end-user experience by providing cloud environments to expose assets to third party application and service developers. For example, IBM announced in late 2009 (IBM, 2009) that it will provide SK Telecom – an incumbent Korean operator – with a complete cloud environment for application development in PaaS (Platform-as-a-Service) mode. As a secure network is an essential element of cloud service business model operators have an increasingly important role in the emerging cloud service markets. The trust issues are becoming more critical for consumers and enterprises as was discussed previously. This gives competitive edge for operators as they have traditionally been "trusted" keepers of sensitive end-user information and they possess the infrastructure and experience for this purpose. A great opportunity for telecom vendors to leverage their existing relationships with operators and combined telecom-IT knowledge to tackle the cloud industry is emerging.

## *4.4 Key trends and uncertainties*

After the collection and identification of the forces affecting the mobile communications industry, initial assumptions were made regarding the most important trends and uncertainties. The initial key trends and uncertainties are presented in Table 3.

Table 3: Initial key trends and uncertainties

| Trends | Uncertainties |
|---|---|
| • Wireless traffic grows (Soc)<br>• Network capacity upgrades (Econ/Tech)<br>  o More base stations and access points<br>  o Backhaul upgrades with Ethernet and MPLS<br>  o Flat network architecture<br>• Coverage upgrades: LTE/WiMAX in developed markets and 3G in emerging markets (Econ/Tech)<br>  o Spectrum re-farming, e.g. UMTS900<br>• Real-time data mgt., billing and charging important: SDM platforms and applications (Econ/Tech)<br>• SDP business grows and operators expose their assets to 3rd party service and content producers (Econ)<br>• Network operations outsourcing (Econ)<br>• Active network infrastructure sharing and roaming agreements (Econ)<br>• Software and services business increases in telecom markets (Econ) | • Industry structure: vertical (access & service tied together) vs. horizontal (access & service separated) (Econ)<br>• MBB access characteristics: Integrated vs. Fragmented (Econ/Pol/Tech)<br>• Network system modularization (Tech)<br>• Operators ability to leverage their ownership of the subscriber data (a) money flows to operator pocket (b) money flows to 3rd party service/content providers pocket (Econ)<br>• Re-awakening of IMS: (a) mass deployments (b) established operators deploy (c) IMS fades (Econ/Tech)<br>• M2M communications business case (Econ)<br>• LTE/WiMAX mass deployments (Tech)<br>• OSS/BSS battle (a) telecom vendors win (b) platform vendors and ISVs win (Econ)<br>• The future of clouds (a) IT and internet players continue to dominate (b) telecom vendors able to enter the cloud markets (Econ/Tech) |

After this a series of industry experts were interviewed to comment and assess the initially selected key trends and uncertainties. Interviews were an intermediate form of "open" and "semi-structured, open-ended" interviews. The main purpose of the interviews was to assess the initially chosen trends and uncertainties and especially the weighing criteria of uncertain elements. The interviewees were also asked some previously defined open-ended questions regarding the probability of base-scenarios[24] and the feasibility for telecom vendor stakeholder group. The interviewed persons included experts of areas such as product and product portfolio managers, strategy developers, sales development managers, technology principals and software business developers.

[24] The verticality of industry structure and fragmentation of MBB access landscape were initially selected as being the two most important uncertainties that form the scenario matrix.

### 4.4.1 Final key uncertainties

Based on the forces study and interview results the final key trends and uncertainties were selected. Some of the initial key trends and uncertainties were removed as they were considered to have rather insignificant impact to the issue of interest. Some trends were moved to uncertainty section as they were considered important and uncertain having the five year time-scale in mind. Also, some of the initial uncertainties were considered as trends rather than uncertainties. Table 4 presents the final key trends and uncertainties.

Table 4: Final key trends and uncertainties

| Trends | Uncertainties |
|---|---|
| • Mobile data traffic growth (Soc)<br>• Capacity upgrades in RAN (more APs and BSs) and backhaul (Ethernet or MPLS over microwave or fiber) (Tech)<br>• Coverage upgrades in developed (LTE/ WiMAX migration) and emerging markets (3G coverage) (Tech)<br>• Spectrum re-farming, e.g. UMTS900 (Reg/Tech)<br>• More licensed spectrum released by regulators (Reg)<br>• Applications drive the entire mobile communications industry (Soc)<br>• Increasing adoption of cloud services (Econ/Tech)<br>• M2M communications increases (Soc/Tech) | • U1: Industry structure: vertical (access & services tied together) vs. horizontal (access & services separated) (Econ) (Econ)<br>• U2: Mobile broadband access characteristics: Fragmented vs. integrated access (Econ/Pol/Tech)<br>• U3: Telecom and Web convergence: value of operator assets and substitution power of IP-based communications (Econ/Tech)<br>• U4: LTE/WiMAX deployments: mass deployment time-scale and specification distribution (Econ/Tech)<br>• U5: Active network infrastructure sharing: operator willingness (Econ)<br>• U6: managed services market: operator interest to outsource (Econ)<br>• U7: Telecom software markets: which players dominate the software markets (Econ/Tech) |

## Industry structure (U1) and mobile broadband access landscape (U2)

The nature of industry structure and mobile broadband access landscape were chosen to be the most critical industry uncertainties. These two uncertainties were selected to form the two-by-two scenario matrix, i.e. step 6 in Schoemaker's method (see section 3.1). To some extend, similar axes to create the scenario matrix were chosen as was used by Smura and Sorri in their study (Smura and Sorri (2009)). Industry structure dimension describes two extremes; the provision of access and services in a bundled package (vertical) or the provision of access and services separately by different players (horizontal). The other key uncertainty was chosen to represent mobile broadband

access for both wide and local area access. The reasoning behind this was to concentrate on growing mobile broadband usage and to analyze the market evolution having a weight on locations and regions where most of the mobile broadband traffic is realized, i.e. densely populated areas such as cities and especially indoor locations.

Next, the rest of the key uncertainties are discussed. Additionally, each below uncertainty is expressed utilizing a five-point weighing scale with two extremes. The scales are utilized to give each uncertain factor a certain weight in each of the constructed scenario.

## Telecom and Web convergence (U3)

Network operators are going after new revenue streams and business models in order to avoid a sole bit-pipe role. This means that operators are looking for technologies and service partners to enable flexible and fast service and content creation environments. Operators are expected to increasingly expose their network assets (e.g. subscriber data information) to third party developers in order to increase the share of revenues received from the content and service markets. To enable service creation and asset exposure telecom vendors and platform vendors have Service Delivery Platform (SDP) offerings comprising of pre-integrated components and related services for operator customers.

The major factor of competitive edge for platform vendors is the economies of scale advantages. Major platform vendors have a vast number of different industries as customers (see section 2.3) making it possible to cost-efficiently produce standardized systems and solutions. These vendors will provide functional components or modules which have no telecom-specificity such as SOA and application environments which are then integrated in telecom vendors' solutions offered to operators.

For the benefit of telecom vendors the basic voice and messaging such as mobile voice and SMS are still widely utilized by consumers. One interesting aspect is that the number of SMS messages has only increased since the introduction of GPRS - one of the first packet based communications solutions - although it was promoted that data communications will almost completely supplement the SMS service once the technology is introduced to the market. The basic voice and messaging traffic is still transported via the traditional circuit-switched (CS) networks which constitute of telecom-specific network elements.

Although a remarkable portion of telecom vendor SDP architecture solutions incorporates systems by ISVs and platform vendors, telecom vendors still holds the expertise of multi-vendor and multi-technology environments. ISVs' and platform vendors' products need to be integrated to telecom-specific systems. This systems integration business related to SDP solutions in telecom environments is strongly represented by traditional telecom vendors.

Based on the interviews one critical uncertainty considering the operator's assets was acknowledged: Will the operator assets really enable new innovative services and business models compared to the current data held already by internet players such as Google?

The internet service players, platform vendors and IP-networking vendors are expanding to telecom area also in SDP business bringing uncertainty to the future role and position of traditional telecom vendors. The critical question is; will internet communications such as Instant Messaging (IM) and VoIP gain a substantial position and replace the traditional voice and communications services such as mobile voice and SMS?

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**U3: Telecom and Web cconvergence**

1. How important or useful the subscriber data owned by operators (e.g. subscriber profile, service utilization, billing status and location) will turn out to be when considering new mobile broadband content, services and possible business models?

| | | |
|---|---|---|
| No clear advantage compared to the data already owned by internet service players such as Google, Amazon and Microsoft | ○ ○ ○ ○ ○ | Gives considerable competitive edge for operators and their partners |

2. Will IP based communications (e.g. IM, VoIP) replace (and to what extend) the traditional voice and messaging communications (e.g. CS voice and SMS)?

| | | |
|---|---|---|
| Complementary | ○ ○ ○ ○ ○ | Replacing |

---

## Migration to "pre-4G" mobile networks (U4)

The timing of mass LTE or WiMAX deployments in developed and emerging market were considered to be an important uncertain element in the future telecom markets. Also the "mass market" definition was clarified to denote a threshold of 50% of commercial market deployments in developed markets.

One interesting point discussed was a so called "high profile" phase in the LTE/WiMAX mobile device evolution where the first "pre-4G" mobile handsets with high price tags are targeted for a niche market segment. After this phase most of the issues related to power consumption, battery life

and multi-band radio support of “pre-4G” mobile devices have been solved and they will become more commoditized and affordable for wider audience. These factors will greatly influence the timing of mass LTE/WiMAX deployments and the timeline of the evolution from “high-profile” handset to commodity handset is yet uncertain.

The utilization of “pre-4G” networks is still yet to be discovered. Will the main services delivered through these networks be categorized as stationary data or will all the issues related to mobile voice over LTE/WiMAX be solved within the next five years? It was previously discussed that LTE is seen as the winning technology family as operators are preparing for the growing MBB traffic. However, the MBB traffic is expected to grow substantially which may cause constraints for 3GPP wide area networks promoting the deployment of substituting technologies such as WiMAX and Wi-Fi.

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**U4: Migration to “pre-4G” mobile networks**

1. When will there be LTE and/or WiMAX commercially available network deployments by half of the operators in developed markets?

2011 ○ ○ ○ ○ ○ 2015 or later

2. In terms of global mobile broadband data what proportion is realized in 3GPP specified networks (air interface)?

30% ○ ○ ○ ○ ○ 100%

---

## Network sharing (U5)

Passive network infrastructure sharing is expected to be utilized in the future regardless of the direction the telecom industry evolves. It’s a win-win situation for competing operators when sites, masts and shelters are shared. However, when it comes to sharing active network infrastructure the most critical aspects to consider are the driver for network build-out (coverage vs. capacity), the balancing between cost reduction and control, and the factors of competitive edge.

The main motivation for operators to engage in network sharing contracts differs based on the market maturity. In developed markets the main motivation is to reduce operational expenditures. For example, by having a shared repair and maintenance team operators are able to cut down costs and confusions. When a site malfunctions it is more feasible to send one team to take care of the problem than having two different teams visiting the same site and trying to solve the issues independently. If current network capacity and coverage in a developed region is enough there is no

reason to make joint upgrade investments putting more weight on OPEX reductions as a main motivation for network sharing activities.

In emerging markets the main motivation for network sharing is CAPEX savings. In emerging markets the network deployments are coverage-driven (e.g. 3G in India and China) promoting operators to deploy and share networks with a joint effort. Similarly, the main driver for network sharing of LTE deployments in developed markets will shift from reducing OPEX to reducing CAPEX.

Based on the expert interview the initial key uncertainty aspects of network sharing were modified. The initial scale from passive to active was removed as it turned out that passive infrastructure sharing will be utilized regardless of the future scenario. The scale was reshaped to indicate the operator interest (or the level of cost pressures faced by operators) to share active network infrastructure.

| **U5: Operator interest to share active network infrastructure / Operator cost pressures** | | |
|---|---|---|
| Low interest / cost pressures | ○ ○ ○ ○ ○ | High interest / cost pressures |

## Managed services markets (U6)

Based on the interviews operator managed services market from a holistic view is considered to be a harmonized coexistence of platform and telecom vendors for now. Telecom vendors have traditionally been responsible for the network part (i.e. access, transport and core networks) and platform vendors for the back office and some areas of business process management such as Business Process Outsourcing (BPO) of operator ICT infrastructure. Both vendor groups are promoting partnerships and observing the market for emerging competitors posing a mutual threat. However, the all-IP communications and standardizing network servers and gateways imply that the so called “grey” area where both vendor groups compete such as the upper layers of OSS solutions (see section 2.1.2) could expand in the future. In terms of network operations outsourcing a full-scale telecom network operations outsourcing by a platform vendor was seen highly unlikely, though.

The uncertain factors of managed services market evolution were considered to be whether the operators are interested in outsourcing network or service layer operations. Operator interest to outsource some or all of its network or service-related operations is constant balancing between cost savings and the degree of control. One interesting aspect having an impact on willingness to

outsource is the ownership of the network infrastructure. It has been speculated that in the future the network infrastructure could be owned by third party investors. In this kind of scenario network operations outsourcing would be highly promoted. There have also been indications that the traditional driver for operator outsourcing of OPEX minimization is giving room to value creation.

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**U6: Managed services markets**

Operator interest to outsource

(a) Network-related operations (planning, deployment, optimization, operations, administration and maintenance)

Low interest ○ ○ ○ ○ ○ High interest

(b) Service layer operations (revenue management, service and content delivery, application development and maintenance, and service hosting)

Low interest ○ ○ ○ ○ ○ High interest

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### Telecom software markets (U7)

As was discussed in the industry background section the major platform vendors are serving many customers in many industries one of them being the telecom industry. Strong benefits from economies of scale and standardized solutions make it possible to deliver these platforms and software solutions cost-efficiently. With rough numbers the customer base of a large platform vendor can be thousand times the customer base of a traditional telecom vendor which makes a substantial difference in solution engineering costs and thus the solution prices.

Based on the background literature study and expert interviews it was observed that the competitive landscape in telecom software business was a crucial uncertainty regarding the future strategic fit between different vendors (platform, ISVs and telecom) and operators. At present the telecom-specificity of telecom software solutions - especially in mobile infrastructure and infrastructure management solutions - still remains high which is keeping platform vendors and their standardized solutions away from the telecom vertical. The question is how long this telecom-specificity will remain as a critical factor for operators so that they are willing to pay rather high prices for them. When operators see cost pressure as more important factor than quality or functionality they will rather buy much cheaper solutions from platform vendors instead of traditional telecom vendors.

**U7: Telecom software markets**

From whom will the operators mostly purchase the telecom software (i.e. software in (1) mobile network infrastructure elements and (2) infrastructure and business management systems (OSS/BSS)) in the future?

Telecom vendors ○ ○ ○ ○ ○ Platform vendors and/or ISVs

## *4.5 Scenarios*

In this section the scenarios are described based on the possible value configurations between the key stakeholder groups. The scenarios are based on the two most critical key uncertainties which form four boundary scenarios of possible future mobile communications industry value systems. The weights of different industry uncertainties were also considered as an input to the scenario construction. Figure 14 presents the four scenarios, their descriptive names and some key characteristics in terms of overall feasibility for different stakeholder groups.

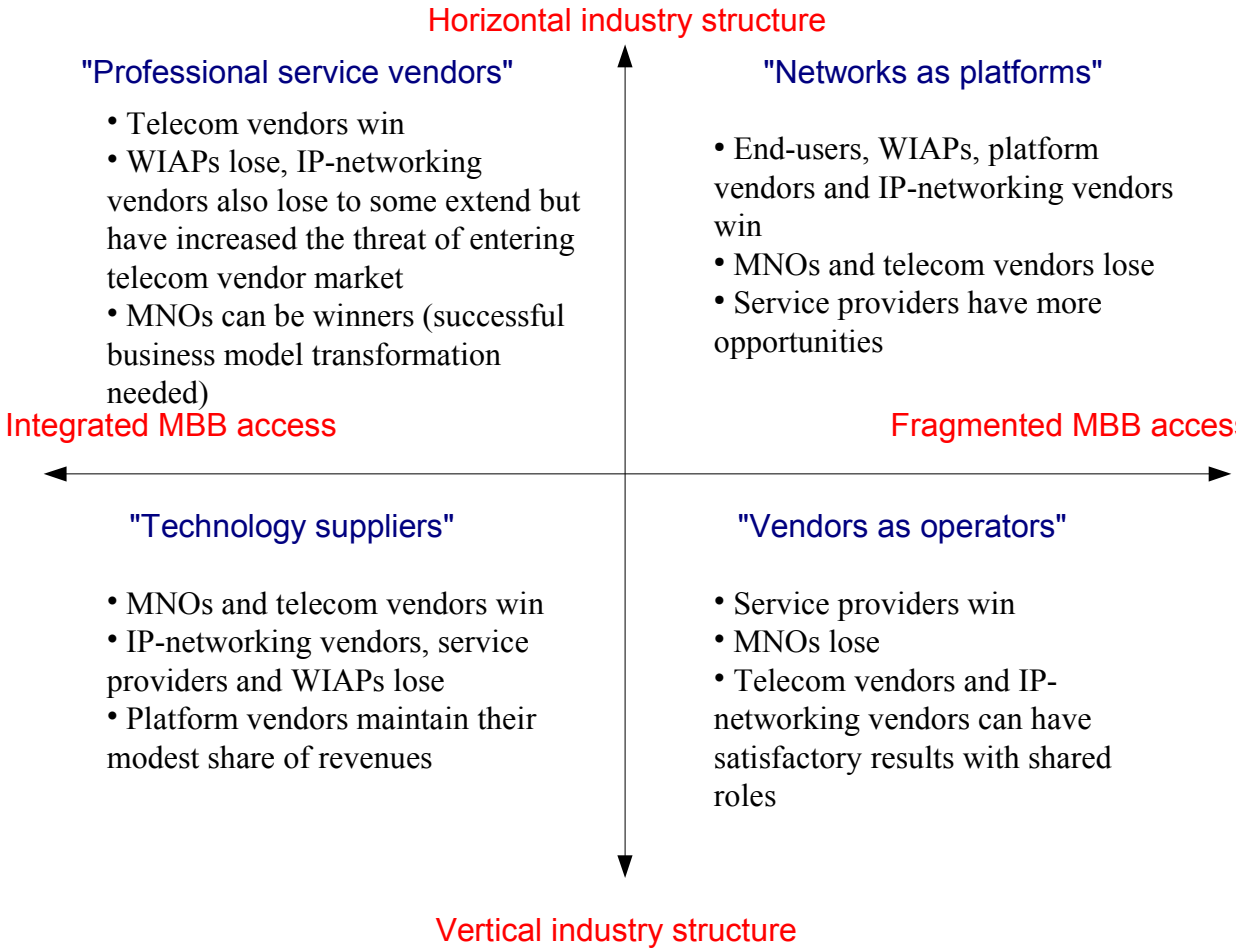


Figure 14: Scenario matrix

Key industry uncertainties were weighed in each of the four scenarios. Five-point scales were used to describe the weight of each uncertain element in each scenario between the two extremes. Figure 15 presents the uncertainty weights in each scenario. After this the scenarios are described individually in terms of possible value system configurations in future mobile communications industry scenarios.

1 = Technology suppliers
2 = Professional service vendors
3 = Networks as platforms
4 = Vendors as operator

**U3: Telecom and Web convergence**

1. The importance of operators' subscriber data assets

No clear advantage ● ○ ● ○ ● Gives clear competitive edge
4 2,3 1

2. The role of IP-based communications

Complementary ● ○ ● ● ○ Replacing
1,2 3 4

**U4: Migration to "pre-4G" mobile networks**

1. LTE and/or WiMAX mass migration time-frame

2011 ● ● ● ○ ● 2015 or later
2 3 1 4

2. In terms of global mobile broadband data what proportion is realized in 3GPP specified networks (air interface)?

30% ○ ○ ● ● ● 100%
3 4 1,2

**U5: Operator interest to share active network infrastructure / Operator cost pressures**

Low interest / cost pressures ● ○ ● ● ● High interest / cost pressures
1 2 3 4

**U6: Managed services markets: Operator interest to outsource…**

(a) Network related operations

Low interest ● ○ ○ ● ● High interest
1 2 3,4

(b) Service related operations

Low interest ● ○ ○ ● ● High interest
2 3,4 1

**U7: Telecom software markets: From whom will the operators mostly purchase the telecom software?**

Telecom vendors ● ○ ● ● ● Platform vendors and/or ISVs
1 2 3 4

Figure 15: Uncertainty weights in each scenario

### 4.5.1 "Technology suppliers"

In the "Technology suppliers" scenario the mobile broadband access landscape is integrated and industry structure is vertical. MNOs have increased their power position significantly in the mobile services ecosystem. This scenario represents a business ecosystem where a few traditional operators

utilize a walled garden type business model where end-users are able to purchase connectivity and the needed services with a possibility to include a mobile device in a bundled package. Operator owned subscriber data and its consolidation and utilization gives considerable competitive edge to customer content and service QoE compared to the data held by internet service players. Innovative applications, services and business models are created utilizing the network and end-user data assets in new successful ways by incumbent operators and their selected development partners from media and internet worlds. Operators are successfully implementing chargeable APIs[25] and their own application stores utilizing revenue sharing business model with third party developers. The value system in the scenario "Technology suppliers" is illustrated in Figure 16.

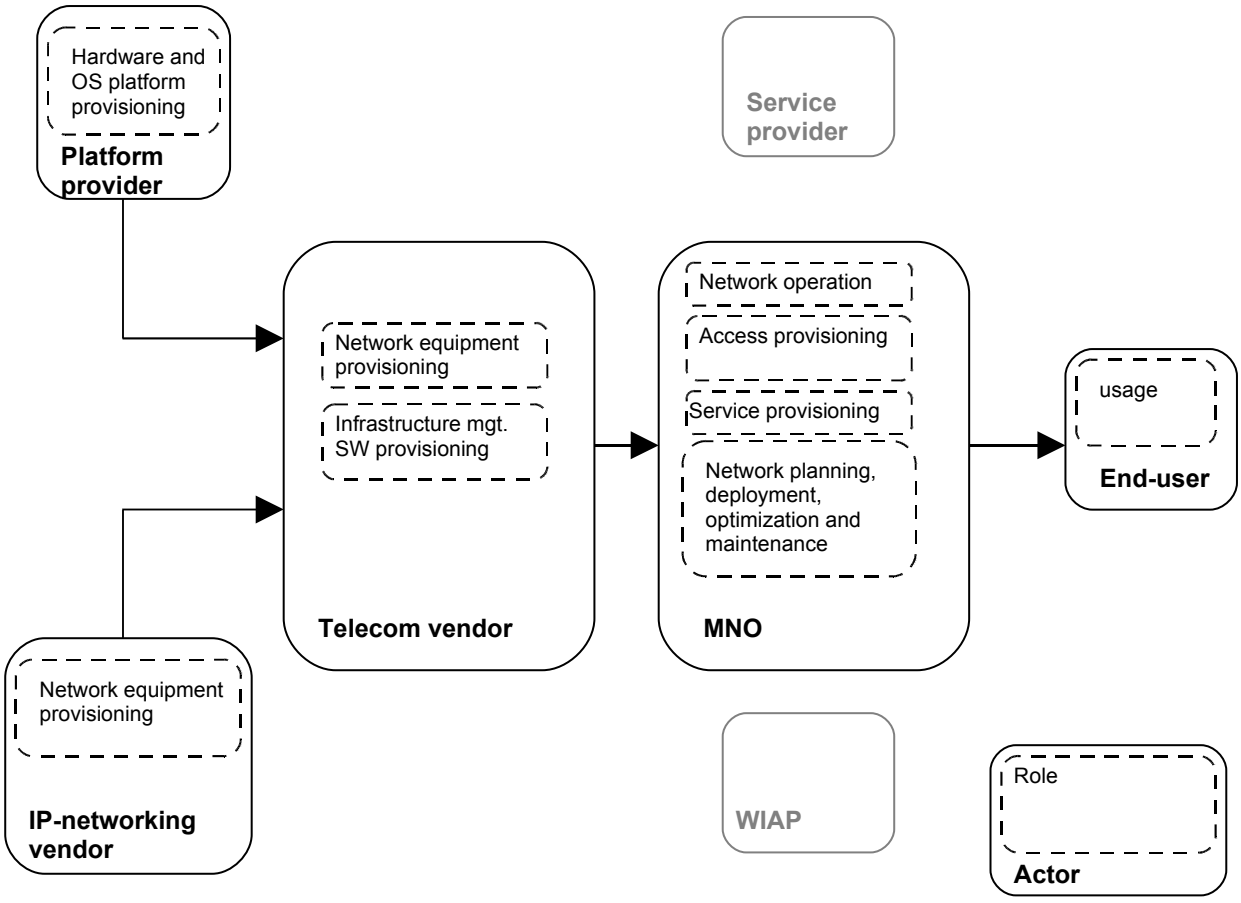


Figure 16: Value system in "Technology suppliers" scenario[26].

[25] A possibility for operators to grow new revenue streams could be to open network APIs such as billing and location for developers who would pay for these closed operator owned network and subscriber data assets (Communicate, 2010).

[26] The size of an actor box roughly describes the market share of each actor on a particular market. Grey-colored actor boxes imply that these industry stakeholders have insignificant role in the value system.

This scenario does not dramatically change the value system in the supply side of the telecom business ecosystem when compared to the present environment. As the access provisioning is integrated technologically and spectrum-wise to 3GPP specifications the networking technology (hardware and software) and interfaces have remained closed in nature and highly telecom-specific benefitting the established mobile operators and traditional telecom vendors. The interfaces from infrastructure (network elements) to the OSS solutions, i.e. the so called north-bound interface, have remained vendor-specific and no standardized, open interface specifications exist keeping the platform vendors with economies of scale advantages away from the telecom space. Operators value and need tailored, highly specified infrastructure management and business management software provided mainly by traditional telecom vendors, decreasing the markets for telecom-specific ISVs. IP-networking vendors providing routers and switches have also remained in the supplier side of the value system selling complementary modules for major telecom vendors.

Operators mainly create their own service portals and application stores relying on their own expertise in technology-wise and business-wise. Strong in-house mentality decreases the opportunity of vendors to provide outsourcing through managed services especially in terms of network operation. However, operators are willing to outsource service and business management processes such as content and service development and assurance to some extend in order to improve subscriber QoE and thus reduce churn. Telecom vendors adopt a role of “technology supplier” and provide large, established operators with hardware and software solutions mostly in a transactional manner. The industry structure, strategic fit between telecom vendors and operators and sources of competitive advantage for telecom vendors are summarized in Table 5.

Table 5: Analysis of scenario "Technology suppliers"

| | |
|---|---|
| **Future industry structure** | To most extend the same as currently (*see* section 4.2), technology interface standardization develops slowly requiring multi-vendor and technology competence of telecom equipment vendors, no credible threat of new entrants or substitute solutions |
| **Strategic fit between traditional telecom vendors and operators.** | Mostly transactional delivery of solutions (hardware and software) |
| **Sources of competitive advantage for telecom vendors** | • Legacy of trusted partnership with incumbent operators, credibility<br>• Multi-vendor and multi-technology competence<br>• Services portfolio to aid operators create their own application stores and development platforms |

### 4.5.2 "Professional service vendors"

In the "Professional service vendors" scenario the mobile broadband access landscape is similarly integrated as it was in the first scenario but now the services and content are mostly provided by different players than connectivity. Major mobile operators have become sole bit carriers who connect users and value added services provided by variety of "over-the-top" internet service players. MNOs are concentrating on providing extremely fast, high-quality bit-pipes for end-users with minimal OPEX and CAPEX making it very difficult for new entrants to enter the "bit-pipe market" cost-efficiently. The business ecosystem aspects shape the value system not only in the vendor customer space but also in the supply side of the telecom industry. The value system of this scenario is presented in Figure 17.

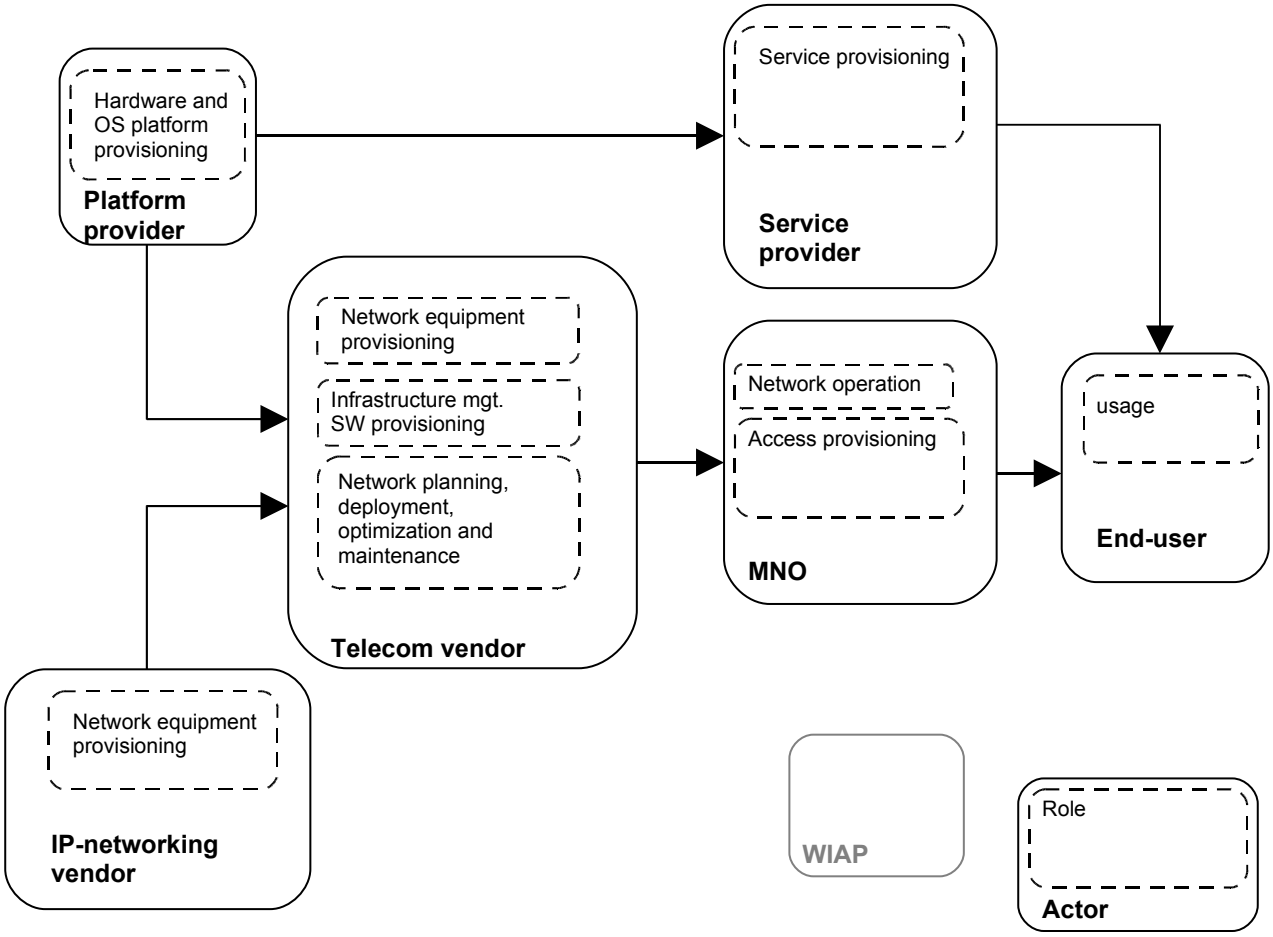


Figure 17: The value system in "Professional service vendors" scenario.

Few incumbent mobile (and/or mobile-fixed) operators provide mobile broadband subscribers with connectivity both in LA and WA locations. HSPA/HSPA+ and LTE are dominating technologies and indoor coverage is extended with 3GPP femtocell technologies. The possible overload of macro BS cells as a result of growing mobile data is partly handled with femtocell technologies utilizing licensed spectrum owned by incumbent MNOs. Traditional telecom vendors are the primary providers of femtocell infrastructure which have developed further in terms of self organization and plug-n-play functionality offering MNOs a cost-efficient way to deploy hundreds of thousands of new femto BSs as end-users themselves are able to set up the BS and plug it into household power supply. However, the telecom vendors are facing increasing threat of new entrants from the internet equipment vendor side as IP-networking vendors have also expanded to the femtocell business making acquisitions and mergers in the industry[27].

This scenario supports the position of traditional telecom vendors rather well. They have long legacy of R&D in 3GPP radio technologies and also strong relationships with incumbent MNOs.

[27] One indication of the evolution of IP players entering 3GPP space is Cisco's acquisition of IP.access – a vendor specified in 2G and 3G femtocell technologies (Cisco, 2008).

These MNOs are doing everything they can to leverage their existing infrastructure. They rely on their legacy partners to plan, optimize and modernize their networks for the most efficient operation via technology upgrades and service solutions promoting the importance of professional services in this particular scenario, especially network planning and optimization consultancy and services. Hardware and software platform vendors and IP-networking equipment suppliers adopt mainly the role of subsuppliers of telecom vendors but the increasing operator cost pressures derived from access margin maximization increases the threat of vendors with economies of scale advantages to enter the telecom space. Also, IP-networking vendors such as Cisco can leverage operator need of complex IP core modernization (Evolved Packet Core) competence brought with LTE deployments to supply solutions directly to operators.

Operators' main concern is to lower the cost per megabyte promoting the network modernization to IP, MPLS and Ethernet environments mostly in mobile backhaul and core networks, and to increase network coverage and capacity with fast roll-outs cost-efficiently. Pursuit for minimized OPEX forces operators to share their active infrastructure with other bit-pipes to some extend and also outsource network operation, care and other business areas to vendor partners. Vendors and operators have very close co-operation with each other and vendors are considered to be MNOs' services and consultant partners rather than simple technology vendors. The industry structure, strategic fit between telecom vendors and operators, and sources of competitive advantage for telecom vendors are summarized in Table 6.

Table 6: Analysis of scenario "Professional service vendors"

| | |
|---|---|
| **Future industry structure** | The existing rivalry is still mostly telecom-specific but platform and IP-networking vendors pose increasing threat of entering the telecom equipment market due to the operator cost pressures and migrations to all-IP networks, Existing rivalry is occurring mainly in the professional services business |
| **Strategic fit between traditional telecom vendors and operators.** | Mostly professional services provisioning to differentiate the technology solutions delivered |
| **Sources of competitive advantage for telecom vendors** | • Legacy of trusted partnerships with incumbent operators, credibility<br>• Low total-cost-of-ownership (TCO) driven solutions<br>• Holistic services portfolio, especially NPO, revenue assurance and possibly OAM<br>• Spectral-efficient WA network technologies backed by a developed 3GPP femtocell product portfolio with efficient SON and plug-n-play functionality |

### 4.5.3 "Networks as platforms"

In the third scenario it is assumed that the networking technology and technology interface standardization has developed to the direction where the network elements have become extremely commoditized[28]. Communication networks are considered as platforms or "factories" on top of which the real business value is added and the interoperability between 3GPP and IEEE networks is flawless. Most of the interfaces outward from network elements to network management systems have been standardized e.g. by TMF[29] and the set of standards have been adopted and accepted widely by vendors and operators opening an entrance for vendors with economies of scale

[28] A metaphor occasionally used here is that access provisioning becomes utility just as running water and electricity are considered to be today.
[29] http://www.tmforum.org/

advantages outside the traditional telecom equipment market. This has benefitted platform vendors who are able to provide standardized platforms for many industry stakeholders with slight modifications. RAN and core network platform components can be differentiated with software upgrades making SDRs reality and in some cases even software defined networks exist on a smaller scale. The business ecosystem is highly horizontialized and fragmented increasing competition on both services and access layers with many competitors and technologies. The value system of "Networks as platforms" scenario is presented in Figure 18.

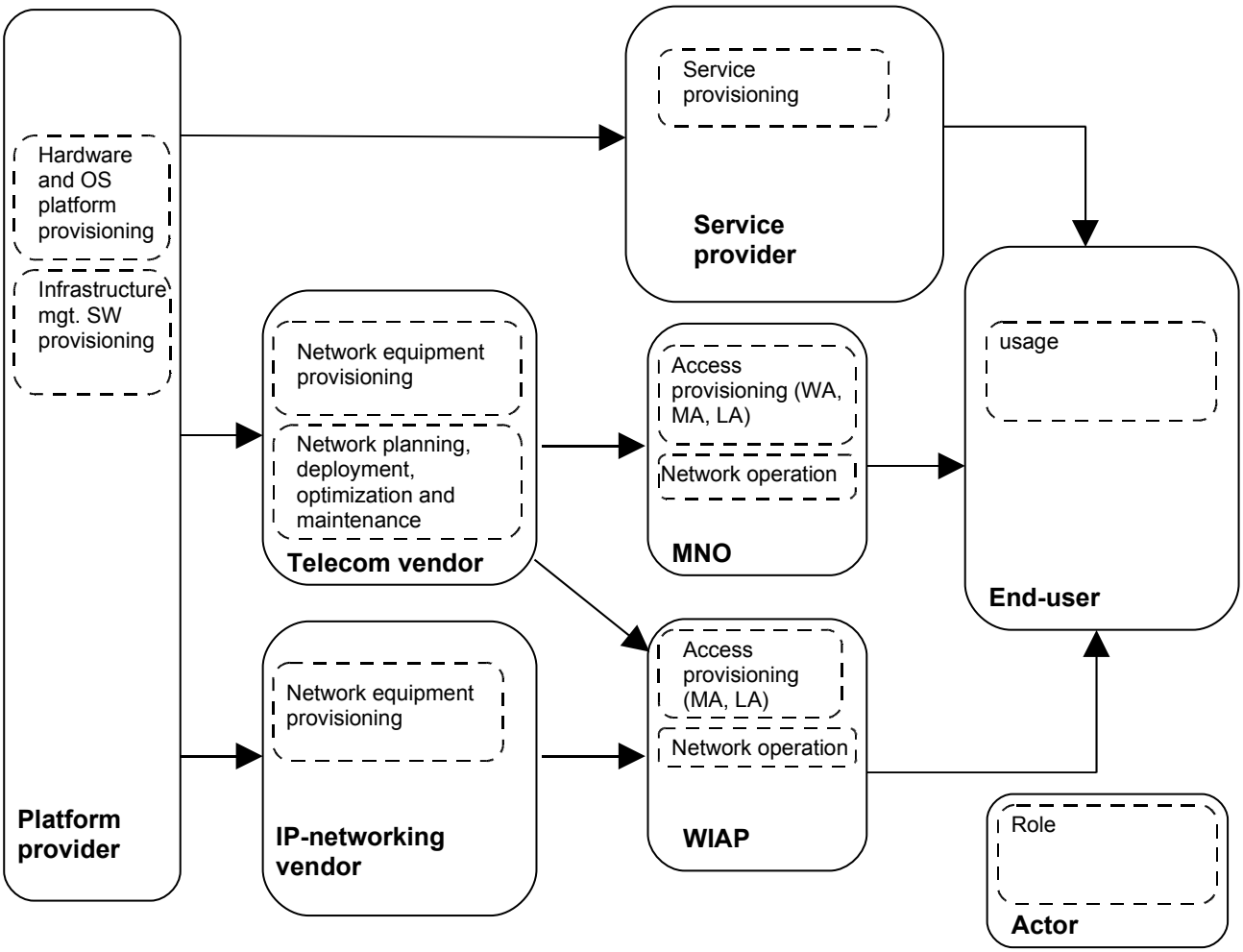


Figure 18: The value system of "Networks as platforms" scenario

In this scenario a huge mobile data growth is realized. A fierce competition in service layer accelerates the trend of free and low cost applications and services. Traditional WA operators utilizing 3GPP technologies have struggled to provide feasible capacity for the growing mobile broadband subscriber base. New players and disruptive technologies have emerged to serve the densely populated areas including metropolitan area (MA) and LA operators utilizing IEEE wireless access technologies. Also the existing WiMAX operators have extended their coverage and some

new Greenfield WiMAX operators have emerged to steal the incumbent MNOs' subscriber base in metropolitan areas by providing fast mobile broadband connections to end-users with WiMAX femtocells. Institutions, enterprises, households and other venue owners utilize their existing Wi-Fi certified 802.11 infrastructure to offer wireless access for mobile users in many new locations by extending their infrastructure in collaboration with Wi-Fi communities, commercial aggregators[30] and IP-networking vendors. This implies that end-users themselves could act as WIAPs by operating Wi-Fi hotspots (i.e. WLAN APs).

The increasing adoption of IEEE wireless technologies changes the telecom industry value system. The increasing number of IEEE specified equipment such as Wi-Fi APs and WiMAX macro and femto BSs in communications networks have made it possible for platform and IP-networking equipment vendors to gain momentum in the telecom industry becoming the direct suppliers for new Greenfield operators and also existing MNOs. Major enterprise ICT and computer networking providers will provide institutions and enterprises with products and services related to their expansions of wireless infrastructure. Standardization of network interfaces has made it possible for major platform providers to sell standardized network management software directly to operators in some cases. Professional services to aid these non-traditional operators to plan, deploy and manage networks are needed and can be provided by non-traditional telecom vendors more increasingly and independently improving their position in the industry ecosystem. Competence in IP data networking and management systems will also give competitive edge to internet and IP-oriented vendors when it comes to planning and deploying highly complex operations and management networks due to the high number of new APs and BSs. However, these new smaller operators have no previous knowledge or understanding on services or end-user QoE aspects opening an opportunity for telecom vendors to address these issues.

At the same time traditional MNOs are struggling as the competition in access markets have driven down connectivity margins. These operators or "defenders" are trying to transform their businesses in order to compete with new agile entrants with disruptive and growth oriented business models. Mobile operators are fiercely searching for new revenue streams engaging in strategic partnerships with their traditional telecom vendors and outsourcing their non-core operations such as network OAM. Traditional MNOs are highly dependent on their legacy vendor partners to survive in the business ecosystem. Low cost equipment and fast, efficient network roll-outs and management are demanded by operators to compete with new entrants and their vendors who offer modular plug-n-

[30] Wi-Fi communities (e.g. FON, http://www.fon.com/) and commercial aggregators (e.g. Boingo, http://www.boingo.com/) provide global authentication schemes for their Wi-Fi AP infrastructure in order to provide wireless broadband access to end-users in hotspot locations.

play wireless access boxes. Operators are looking for strategic partners to share risks of investment as the service and content revenues and also connectivity revenues are flowing to variety of pockets. Traditional telecom vendors have shifted from the sole technology provisioning to more software oriented business models through mergers and acquisitions with telecom-oriented ISVs leveraging their knowledge of legacy infrastructure and operator current needs. Telecom vendors are engaging in strategic relationships with MNOs and emerging operators providing them with flexible risk and revenue sharing solutions to lower front-end investments. The industry structure, strategic fit between telecom vendors and operators and sources of competitive advantage for telecom vendors are summarized in Table 7.

Table 7: Analysis of scenario "Networks as platforms"

| | |
|---|---|
| **Future industry structure** | New rivals (HW & SW platform and IP-networking vendors) have entered the industry from supplier and substitute spaces and taken partly the role of equipment suppliers, traditional telecom vendor stakeholder group is consolidating through mergers and acquisitions |
| **Strategic fit between traditional telecom vendors and operators.** | Close co-operation with traditional telecom vendors and operators, flexible pricing models and sharing-type (revenue and risk) business models are utilized |
| **Sources of competitive advantage for telecom vendors** | • Legacy system and integration knowledge<br>• Solution portfolio with comprehensive set of flexible and pre-integrated solutions, infrastructure leasing<br>• Sustainable software business execution and comprehensive OSS/BSS solutions portfolio for business and service management layers<br>• Holistic solution portfolio combining 3GPP and IEEE technologies |

### 4.5.4 "Vendors as operators"

The fourth scenario describes a mobile services ecosystem where large internet service providers such as Google, Microsoft and Amazon have extended their power position to the mobile access market. Both MNOs and local operators are mainly wholesaling connectivity to the internet service players which are contracting with the end-user for bundled service packages including mobile broadband access, services and devices. A good example of vertical expansion by internet service providers is the Amazon Kindle[31] – software and device platform with in-built cellular access capability for downloading and reading electronic books (also newspapers, blogs, etc.). By purchasing a Kindle end-user contracts directly with Amazon for the device and access to the service. This scenario indicates major movements in the mobile value system which is presented in Figure 19. It can be seen that both operators and vendors have shifted one tier away from the revenue source, i.e. the end-user, decreasing the operator and telecom vendor industry attractiveness and overall profitability.

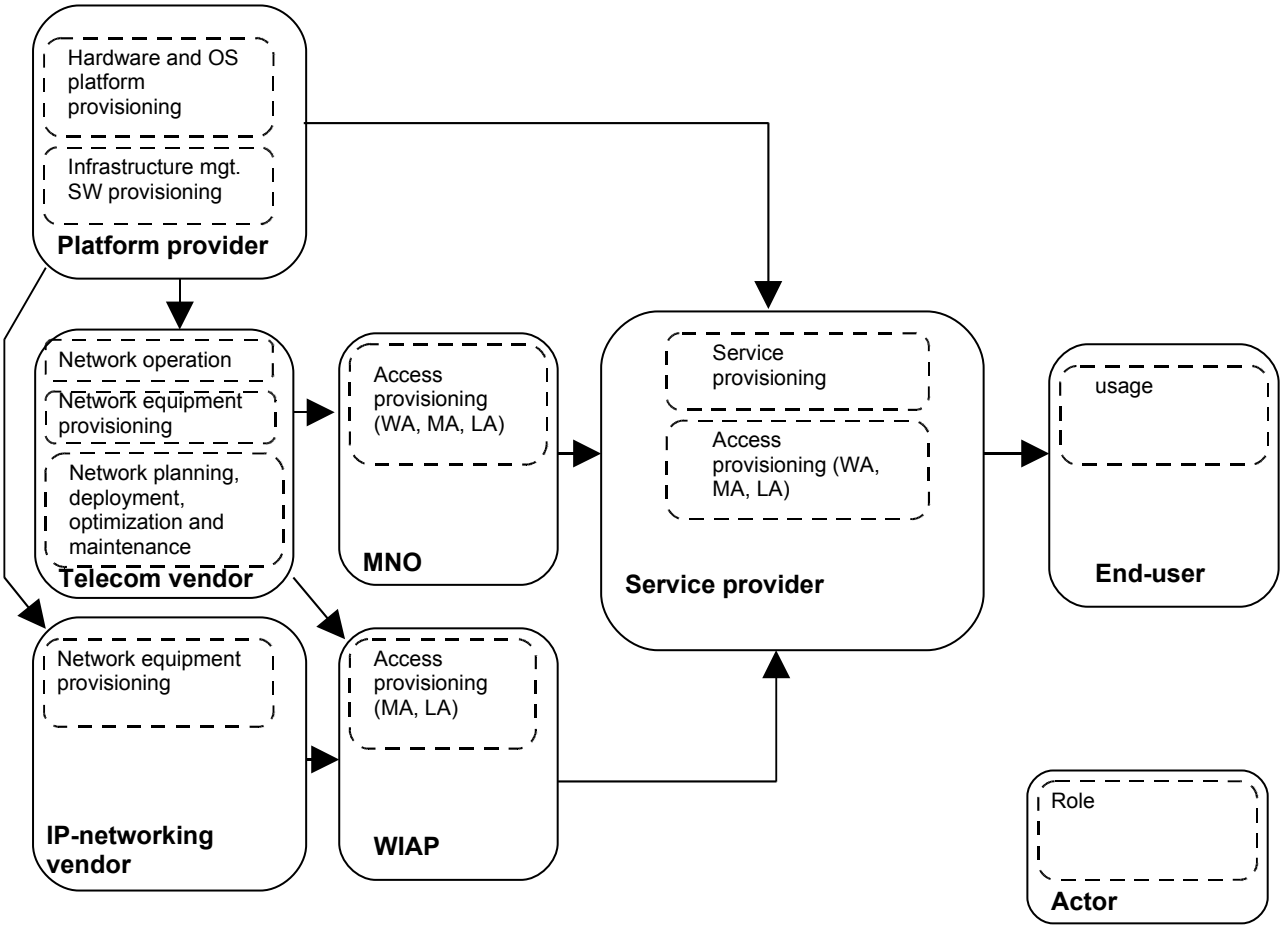


Figure 19: The value system in "Vendors as operators" scenario

[31] http://www.amazon.com/kindle

The evolution of telecom infrastructure technology has developed substantially to the same direction as in the previous scenario. The situation is not the most feasible one for incumbent MNOs and their traditional vendors. Hardware and software platform vendors and IP-networking equipment suppliers have become rivals in the telecom vendor traditional core market and offering networking infrastructure solutions with rather cheap prices enabled by the economies of scale advantages. Traditional telecom suppliers are struggling to compete with IP-equipment vendors' prices and are concentrating mainly on 3GPP technologies but also provide professional services for operators deploying IEEE technologies.

Incumbent MNOs are under heavy cost pressures as they are mainly selling connectivity to organizations with professional and centralized buying organizations. This arrangement will decrease the revenues per megabyte to the minimum. Operators concentrate on selling their bit-pipes to service operators and let telecom vendors to handle the operations and maintenance of the network in order to minimize OPEX. The cost pressures force MNOs to adopt active network sharing agreements with each other to minimize operational costs and investments. New infrastructure has been deployed by WiMAX supporters to expand the coverage of WiMAX networks and indoor capacity is mainly provided by venue owner Wi-Fi infrastructure expansions and WiMAX femtocells. In many municipalities and metropolitan areas WiMAX and Wi-Fi networks offer seamless mobile broadband connection for end-users. Large internet service operators, IP and computer vendors play an essential role in IEEE network deployments as investors having strategic alliances with WiMAX operators and venue owners[32]. These movements indicate a possibility that MNO or smaller local operator has an outsourcing contract with a telecom vendor for network operation and the whole network infrastructure and spectrum is owned by third party investors. Adding to this the scenario characteristics of large internet service providers owning the end-users and service delivery, the role of an operator is becoming rather vague compared to their position in traditional mobile business ecosystem at present.

Traditional telecom vendors have leveraged their legacy of co-operation with operators and current managed services contracts to acquire new customers and renew the old network outsourcing contracts. Telecom vendors also leverage their competence in legacy telecom infrastructure of multi-vendor technologies and provide consulting services to operators and IP-networking vendors. Operators are modernizing their networks by replacing old telecom-specific network elements with IP-specific network elements as migration to all-IP architectures evolves and internet-based

[32] For example, Google, Intel and Cisco are some of the main investors in Clearwire WiMAX deployment in Silicon Valley, California (Cisco, 2009).

communication such as instant messaging (IM) and VoIP increasingly replaces traditional circuit voice and SMS services. The industry structure, strategic fit between telecom vendors and operators and sources of competitive advantage for telecom vendors are summarized in Table 8.

Table 8: Analysis of scenario "Vendors as operators"

| | |
|---|---|
| **Future industry structure** | High competition in networking equipment market (price-centered); the number of operators adopting IEEE technologies increased and addressed by IP-networking, platform and telecom vendors; Low cost 3GPP technology suppliers gain market share |
| **Strategic fit between traditional telecom vendors and operators.** | Telecom vendors are operator's outsourcing partners |
| **Sources of competitive advantage for telecom vendors** | • Proven track-record of successful network outsourcing contracts<br>• Sustainable software business execution and comprehensive OSS/BSS solutions portfolio for business and service management layers targeted also to internet service player customers |

Figure 20 presents the value systems of all the constructed scenarios.

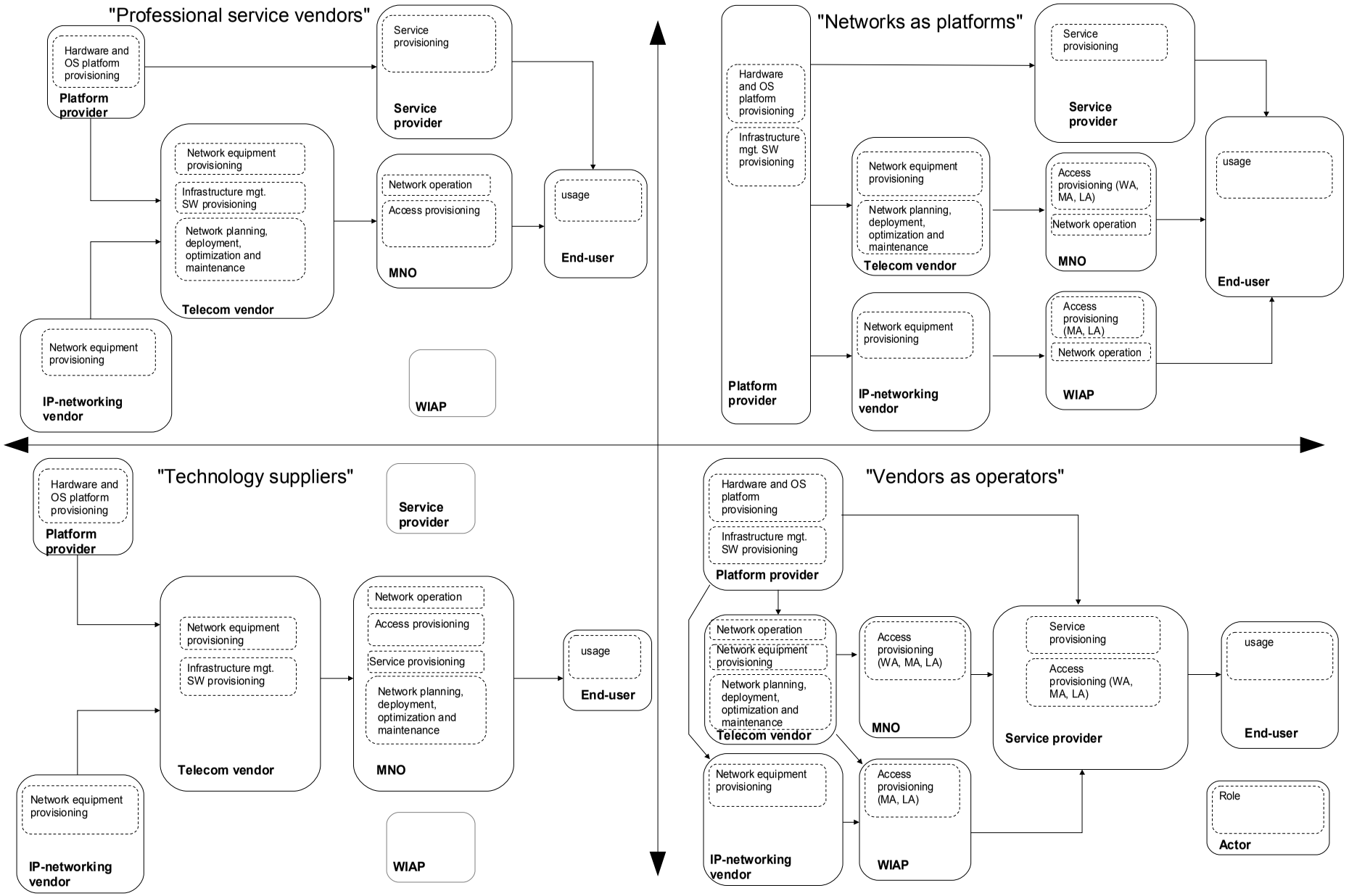


Figure 20: Scenario value systems

# 5 Strategic implications

In this chapter strategic implications for telecom vendors in general are discussed based on the Porter's five strategic approaches under industry uncertainty (see section 3.3.2).

The order of the discussion of five strategic approaches is based on the order they are presented by Porter and thus does not imply that the most feasible strategies for a telecom vendor are introduced before others.

## *5.1 "Bet on the most probable scenario"*

The fundamental idea behind this strategy is to choose a scenario or a range of scenarios which are expected to occur with higher probability than other scenarios (see section 3.3.2). According to Porter by choosing this strategic approach the most critical aspects a firm should consider are the following:

1. The probability that the selected scenario (or a range of scenarios) will occur
2. The consequences if some other scenario other than the chosen one(s) occurs
3. The current resources and positioning of a firm in the industry ecosystem in terms of competitive advantage

Based on the industry expert interviews and industry announcements, especially the ones where major operators express their plans to deploy LTE networks (Ericsson (2010b), Vodafone (2009)) it was deemed that scenarios with integrated mobile broadband access landscape were more probable to occur than the ones with more fragmented and heterogeneous access landscape. As the scenario descriptions are intentionally slightly overstated in order to make clear distinctions between the possible future outcomes the general opinion was that the most probable future outcome would be somewhere in the middle of the industry structure dimension (i.e. the y-axis), slightly more in the "Professional service vendors" quadrant and increasingly shifting towards the horizontalized industry structure. The reasoning behind these views was the substantial investments made by major operators in 3GPP mobile network infrastructure and frequency licenses. It was argued that these investments would be protected to some extend also by regulatory implying that spectrum management would remain rather centralized and the license ownership would still bring incumbent MNOs competitive edge against smaller agile players and possible Greenfield entrants. Although the technological development is seen very rapid and having a substantial impact on the whole

industry the time frame of five years ranging from 2010 to 2015 was considered to be slightly too short to incorporate such substantial shifts in mobile broadband access landscape as was described in fragmented access scenarios.

The industry structure in "Professional service vendors" scenario is somewhat similar than of today's implying that no major resource or strategic positioning gap exists between the current industry ecosystem and this particular future scenario. Similarly mobile operators – of which the majority has 3GPP-specified network infrastructure – would be addressed mainly by traditional telecom vendors providing them with complete end-to-end solutions including hardware, software and a broad portfolio of professional services. If "Professional service vendors" scenario occurred the industry evolution would have evolved in a way that it is expected to evolve at present by industry experts implying that services business in telecom equipment markets will increase and its role is more increasingly becoming the major differentiator and source of competitive advantage of existing telecom vendors.

Based on the above discussion the betting strategy for the most probable scenarios incorporates concentration on a number of certain organization's primary activities and narrowing down the technology solution portfolio. First of all, fully betting on scenario with an integrated access landscape promoting only 3GPP, wide area mobile technologies would mean dropping out completely IEEE-based technologies such as 802.16 (WiMAX) and 802.11 (Wi-Fi) standard families from the network solution portfolio in order to gain competitive advantage over competitors. This strategic choice would also promote decreasing resource commitments on IEEE related alliances and consortiums such as WiMAX Forum[33] and Wi-Fi Alliance[34]. Similarly, partnerships with operators and other vendors or suppliers from the IEEE technology sector should be reviewed and the largest resource commitments withdrawn. However, existing relationships with WiMAX and Wi-Fi operators should be maintained in order to support possible migration from IEEE technologies to 3GPP technologies in the future.

The resources withdrawn from the relationships management and solution portfolio of IEEE technologies should be committed to fully support 3GPP technology R&D. A telecom vendor should extend and improve current 3GPP mobile technology portfolios such as WCDMA, HSPA and LTE. In "Professional service vendors" scenario the migration towards "pre-4G" mobile technologies is the fastest and many MNOs have commercial LTE deployments already in 2011 at least in metropolitan areas. Fierce competition among operators to offer end-users high-quality bit-

[33] http://www.wimaxforum.org/
[34] http://www.wi-fi.org/

pipes with extensive coverage and fast mobile broadband data rates ubiquitously exists. The local area access landscape is dominated by 3GPP femtocell technologies and operators value fast and cost-efficient network deployments with high-level of automation. This aspect promotes vendors to start investing in femtocell technologies early and develop SON capabilities in order to enable highly automated femtocell BS deployments and network configuration.

As content and services are mainly provided separately from connectivity the scenario implies that the network and subscriber assets owned by operators will not provide the essential information for creating innovative new applications, content and services thus making these revenue streams for operators insignificant. This aspect of mobile industry's services market horizontalisation implies that telecom vendors should withdraw some resources from holistic service delivery platform (SDP) development and maybe direct the remaining resources to some specific area of SDPs in order to minimize the risks of not receiving decent returns on SDP R&D investments. One possibility would be to invest in secure asset exposure solutions and versatile, real-time billing platforms for operators. In this way operators could leverage their existing infrastructure and other assets the most beneficial and profitable way by selling third party developers and service operators network assets and providing them with real-time user data and billing capabilities.

The consequences of less probable scenarios occurring are rather adverse if betting for the most probable strategy is selected. The most adverse consequence would result from choosing an unbalanced technology portfolio. By completely abandoning the IEEE technology development a huge portion of addressable market is lost if a scenario with more heterogeneous access landscape occurs. If technology interface standardization evolved to a direction where platform and IP-networking vendors could address MNOs more directly and with considerably lower prices the committed resources in exhaustive 3GPP technology R&D (HSPA+, LTE and related femtocell technologies) would not pay-off as expected. The strategic implications for "bet on the most probable scenario" approach and its strengths and weaknesses are assessed in Table 9.

Table 9: Assessment of the "Bet for the most probable scenario" strategy

| | |
|---|---|
| **Strategic implications** | • Move resources from IEEE solutions to 3GPP solutions in terms of R&D<br>• Aim for low TCO products in general and develop comprehensive 3GPP femtocell product portfolio with SON capabilities<br>• Decrease resource commitments in comprehensive SDP development<br>• Promote services portfolio and past success stories |
| **Strengths** | • More advanced HSPA, HSPA+ and LTE technology solutions than competitors<br>• Extensive 3GPP femtocell product portfolio with automated SON capabilities<br>• The present positioning and strategy of most of the established telecom vendors is not very far from this strategy<br>• Promoting 3GPP technologies will keep mobile infrastructure technologically "closed" in nature keeping IP-networking and platform vendors away from telecom vendor market |
| **Weaknesses** | • Weak or no WiMAX/Wi-Fi portfolio at all; if fragmented access scenarios occur WiMAX/Wi-Fi markets can not be addressed<br>• Focusing heavily on network layer and leaving services layer solutions with lesser attention could facilitate large amount of revenues to flow to competitors' (other telecom vendors, platform vendors and ISVs) pockets |

## *5.2 "Bet on the best scenario"*

The fundamental idea of "Bet on the best scenario" strategy is to commit resources early to formulate a strategy for a scenario (or a range of scenarios) that is deemed to be the "best". By the term "best" Porter implies to a scenario where a firm can *establish the most sustainable long-run competitive advantage given its initial resources*. The list below introduces the main aspects that need to be taken into consideration when designing "bet on the best scenario" strategy.

1. Assess which scenario (or a range of scenarios) is considered to be the "best"
2. Assess scenario probabilities
3. Assess the degree of inconsistency among strategies in different scenarios

Based on the expert interviews it was unanimously seen that the most feasible scenarios for telecom vendors were the ones with traditional telecom specific access landscape with 3GPP-led mobile

network technologies and few incumbent MNOs providing mobile broadband access to end-users. The most feasible scenario for both MNOs and telecom vendors was seen to be "Technology suppliers" scenario. The main reasoning behind this selection was that in this scenario operators probably have the least cost pressures and a considerable role in the end-user QoE and in overall content and services market. Although "Technology suppliers" was seen to be the most feasible scenario it was also ranked as the least probable scenario to occur by most of the interviewees.

The major difference between "Bet for the most probable scenario" and "Bet for the best scenario" approaches is the resource commitments to comprehensive, MNO-vertical SDP (see section 2.4 for SDP description) development. In order to be competitive in "Technology suppliers" scenario a telecom vendor should be able to offer MNOs comprehensive solutions, including hardware, software and services for managing every aspect of service delivery environment. In this scenario the networking technology and interfaces would be highly telecom-specific and every telecom vendor would have their own vertical solutions for implementing SDPs and related technology interfaces (interfaces from SDP towards network elements, OSS/BSS systems and third party applications and content). Competitive edge is gained via a complete integration and transformation solutions, including consultancy, planning, delivery, integration, testing and optimization, and even outsourced operations of service delivery architectures. A winning solution offered to MNOs would encompass secure asset exposure capabilities, service creation environment and comprehensive set of pre-integrated solutions for fast roll-out of new content and services. Also, platforms and other ready-made tools for MNOs to establish their own app stores[35] would give a telecom vendor competitive advantage over others. The strategic implications for a "Bet for the best scenario" approach and its strengths and weaknesses are assessed in Table 10.

[35] One such an example is Ericsson's eStore – a market place (or platform) where operators can implement own application stores (Ericsson, 2010).

Table 10: Assessment of "Bet on the best scenario" strategy

| | |
|---|---|
| **Strategic implications** | • MNO-vertical SDP environment solutions including joining forces with or acquiring third parties (3rd party content and developer management, secure asset exposure, chargeable open APIs)<br>• Development of application store platforms for MNOs<br>• No WiMAX or Wi-Fi solution portfolios, only 3GPP mobile solutions (2G, 3G, LTE) including femtocells |
| **Strengths** | • Substantial competitive edge in both radio network infrastructure and SDP markets |
| **Weaknesses** | • The best scenario has a limited chance to occur<br>• The strategy is rather inconsistent with an optimal strategy in scenarios with more heterogeneous access landscape |

## *5.3 "Hedge"*

Hedging is a "robust" approach to aim for satisfactory results in every scenario (see section 3.3.2). As a result of hedging a suboptimal strategy is adopted. This delivers no substantial competitive edge compared to competitors in any of the constructed scenario albeit the resources are committed early. As discussed earlier the main benefit of this strategic choice is to mitigate risks encompassed in industry uncertainty. When formulating hedging approach the most critical choice criteria to consider are the risk factors and costs. The most important risk factor is the deemed scenario probabilities. Hedging is a way to prepare for many possible outcomes simultaneously but if some scenario (or a range of scenarios) is seen to occur with a substantially higher probability it is feasible to slightly weigh the scales towards these scenarios and strategic choices related. Another critical aspect to consider is the costs, especially the amount of resources available to execute hedging and the costs of changing strategy once uncertain factors begin to clarify. First of all a firm needs to consider if the available resources are enough to even choose an efficient hedge strategy in the first place. The second important cost-related aspect is to consider the irreversibility and the degree of locking-in once the hedge strategy is put in motion. Below are listed some of the most important aspects to consider when formulating hedging strategy.

1. Scenario probabilities

2. Costs required to implement efficient hedging strategy

3. Costs required to change strategy

4. Common factors present in every scenario

In general, hedging strategy promotes focusing on industry trends which are expected to occur with relatively high probability as the industry evolves. Committing resources to these areas (see section 4.4 for industry trends) will aim for securing a rather safe position for a firm in the future although it may give no substantial competitive edge relative to competitors. Besides focusing on industry trends rather than betting for factors with high uncertainty a telecom vendor should concentrate on maintaining or slightly increasing market share rather than targeting for increased profitability. This should be taken into consideration especially under the present stagnate telecom CAPEX environment. In terms of managing services business telecom vendors should successfully fulfill operator expectations and start negotiations early for contract renewals. Managed services deals signed during the past recent years will be expired approximately by 2015 and if contract renewals are stolen by main rivals, market share is lost with substantial amount of revenues.

For a traditional telecom vendor hedging implies that a firm would aim for a broad technology and service portfolio. When considering mobile broadband infrastructure technologies a vendor should support both 3GPP and IEEE technology lines. Many established telecom vendors are betting more intensively on 3GPP solution lines. Yet, one of the key uncertainties (see section 4.4.1) implies that there exists a possibility that mobile network access would turn out to be more heterogeneous indicating that WiMAX and Wi-Fi equipment and services market would grow as substitutes to traditional cellular technologies. By supporting both standardization families and maintaining partnerships and collaboration also with IEEE-specific forums and consortiums a vendor could address wider market if more heterogeneous access landscape occurs. However, hedging choice criteria suggests that scenario probabilities need to be taken into consideration indicating that slightly more effort and resources should be committed to support 3GPP technology solutions as access landscape is expected to remain rather integrated.

An important industry trend is the growth of mobile data traffic and possible constraints with indoor coverage and capacity (see section 4.3.3). This trend is expected to occur regardless of the uncertain scenario elements discussed previously. Hedging aims to satisfactory results in whatever scenario eventually occurs. Committing resources to tackle business areas impacted by industry forces that are considered to be “trends” is necessary in order to hedge against maximum losses. With this in mind, vendors should prepare themselves for macro cell capacity constraints with femtocell

technologies for both 3GPP and WiMAX standard families. Operator OPEX and CAPEX constraints are not expected to ease off in the coming years promoting the need for cost-efficient capacity upgrades for densely populated areas and indoor locations. To address these operator problems during the coming years vendors should be able to offer 3G, LTE and WiMAX femtocell solutions with developed SON capabilities. Hedging approach would also promote the development of interworking between 3GPP and IEEE networks internally. Then, if more heterogeneous access landscape emerges, the vendor would have solutions available for operators regardless of the deployed technology. It should be noted that in scenarios with more heterogeneous access landscape the interoperability between different wireless network technologies is possibly demanded by regulatory.

To mitigate the risk of platform and IP-networking vendors entering the telecom sector more intensively, telecom vendors should break away from network-centric and especially hardware-centric mentality. A serious shift from hardware to software and service-centric business models should be implemented as IP-based technology increases its role in traditional telecom technologies and the greatest business value lies in services, content and applications instead of connectivity provisioning. Telecom vendors should prepare themselves for the situation where internet-based networking technologies become the core market where even the next generation 3GPP technologies (i.e. LTE and LTE-Advanced) will be partly developed and supplied by new players mainly from the IP-networking and software industries. In order to hedge against this threat telecom vendors should be precocious to partner and collaborate with more IP-centric vendors. As was discussed earlier (see section 4.4) the industry is experiencing the trend where MNOs are preparing for explosive mobile data growth by upgrading their mobile backhaul networks with carrier grade Ethernet and MPLS solutions. By joining forces early with IP-vendors and beginning with addressing particular sectors of networks (e.g. mobile backhaul) or service layer (e.g. service management) telecom vendors can share the possible market rather than vacate it completely to economies-of-scale-vendors if the worst case scenario is to be realized.

The possible industry's technological evolution mentioned above should also be taken into consideration when telecom network management system (OSS) strategies are formulated. Today traditional telecom network (i.e. 2G and 3G) management market can only be addressed by telecom vendors. In the future, however, the increasing amount of IP technology in telecom networks indicates that future, next generation telecom networks[36] (e.g. LTE and LTE-Advanced) could be

[36] In the future the concepts of telecom and data networks may disappear and a new, common term for a network carrying both voice and data based on Internet Protocol emerges.

managed with generic data-networking management systems provided by large platform and IP-networking vendors. The important factor to follow here is the amount of modifications needed to be implemented in generic, low cost IP-network management solutions in order for them to be able to handle telecom networks and their strict, carrier grade requirements. This is why vendors should seriously consider developing IP-network management solutions possibly in partnerships with existing platform and IP vendors to strengthen the position and hedge against maximum losses in a possible fully IP-centric network environments in the future.

The growing markets of software and services in telecom equipment industry should be considered when hedging. In order to survive in a business ecosystem where network is virtualized and the underlying equipment is commoditized telecom vendors should have capabilities for lean and profitable software and services business. This requires telecom vendors to transform their organizations internally in terms of processes and organizational structure to cope with the services-oriented business models. The old-fashioned firm value chain concept should be updated and reshaped involving value shop and network (see section 2.2.2) models to better understand the meaning of each primary and secondary activity and their contribution to the company's value proposition and creation. The same applies to telecom software business which has grown substantially[37] and shows no signs of losing its dominating role in telecom vendor solutions. This is why telecom vendors should be able to implement efficient recurring-revenue-based software business similar to strong and successful ISVs such as Oracle. Telecom vendors should be able to match the proportion of resources spent on software development and maintenance with the proportion of revenues received from software solutions. However, it is difficult to change the traditional operator culture to which they have adjusted; operator pays high up-front investments after which significantly lower payments for asset management and maintenance are made. This has worked well in the past as hardware-driven solutions are easy to maintain and repair relative to software solutions. Software products need constant maintenance (e.g. software updates) and when faults emerges it is very difficult to determine which part of the software is causing defects and by which vendor that particular part is supplied. This is why vendors should also be able to offer modular software solutions and flexible pricing models which enable operators to take more functionality in use gradually and pay for the solutions based on the realized business case. In this way a telecom vendor could prepare for a scenario with emerging local area operators and also address this Greenfield market.

[37] For example, Ericsson CEO Hans Vestberg claims that Ericsson has become the worlds fifth largest software company (Ericsson, 2009).

The strategic implications for "Hedge" approach and its strengths and weaknesses are assessed in Table 11.

Table 11: Assessment of "Hedge" strategy

| | |
|---|---|
| **Strategic implications** | • Aim to maintain or slightly increase market share rather than profitability<br>• Commit resources to successfully fulfill operator expectations with outsourcing deals and start negotiating contract renewals early<br>• Commit resources for both 3GPP and IEEE technology R&D (also 3G, LTE and WiMAX femtocells and SON capabilities)<br>• Partner more strategically with platform and IP-networking suppliers for infrastructure and infrastructure management solutions<br>• Efficient software business models to match the resources spent and related revenue streams<br>• Flexible software pricing and modular system design |
| **Strengths** | • Market share protected better than competitors whichever scenario occurs<br>• Both 3GPP and IEEE technology lines<br>• Wide overall partnership network, especially with IP-networking vendors |
| **Weaknesses** | • High costs required to implement<br>• Generally, competitive edge related to competitors weakened in every scenario<br>• Weaker 3GPP and IEEE portfolios than single-technology-oriented competitors |

## *5.4 "Preserve flexibility"*

Porter's approach of "Preserve flexibility" is another "robust" approach along with hedging. Fundamentally, it is all about postponing resource commitments until it gets clearer in which direction the industry is evolving. By delaying resource commitments it is clear that risks involved in uncertainty are mitigated but with a cost of weakened first-mover advantages. Preserving flexibility is also the best way to control costs related to changing strategy once industry uncertainties begin to unfold. The list below summarizes the key aspects of preserving flexibility strategy and the areas that need to be taken into consideration when this approach is chosen.

1. Definition of important "checkpoints" that give more concrete indications of the industry's outcome

2. Which resource commitments are irreversible that tend to lock vendors into a chosen strategy

3. Weigh first-mover advantages against risk mitigation resulting from delaying resource commitments

4. Close observation of causal factors behind key uncertainties in order to get insights about the correct timing of resource commitments (the earlier resources can be committed the less is suffered from drawbacks resulting from postponing)

One important "checkpoint" to observe in terms of mobile broadband access landscape is the migration choices of major mobile WiMAX proponents in both operator (e.g. Clearwire (U.S.), Yota (Russia), Tata (India) and UQ Communications (Japan)) and vendor (Motorola, Samsung, Cisco and Alcatel-Lucent) markets. Substantial growth of mobile data is expected (see section 4.4) within the next few years and it may come about that these WiMAX operators need serious capacity upgrades in order to compete with LTE networks' coverage and data rates. WiMAX 802.16m[38] technology is considered to be LTE's direct rival but it is still rather unaccomplished compared to LTE in terms of trial and commercial deployments. Thus, telecom vendors should wait to see how the WiMAX markets will evolve within the next few years. Will WiMAX operators choose to continue supporting this technology line by implementing the next generation WiMAX (802.16m) or will they initiate migration projects towards 3GPP's LTE radio access networks? And how the vendors will commit resources to the development of the next generation WiMAX technologies? Until these areas of uncertainty unfolds the telecom vendors with more 3GPP-oriented technology lines should mainly source WiMAX (and possibly Wi-Fi) technologies from other vendors. In this way a telecom vendor could offer wide array of products and maintain reputation of being a real end-to-end solution provider regardless of technology.

Another area to be observed while postponing resource commitments is the evolution of software-defined radios (SDR) and interworking between different network technologies. Extensive resources should not be committed to vendor-specific, closed next-generation network technologies such as LTE product portfolio. With a considerable R&D budget for "vertical" LTE development vendors are forced to charge higher prices to encompass the expenditures. If network interworking evolves making ubiquitous access reality regardless of the used device or network technology operators will have the cost issues on top of their minds instead of technology aspects or vendor

[38] IEEE standard 802.16m (a.k.a. Mobile WiMAX Release 2.0) is argued to fulfill ITU-R's requirements for 4G mobile technologies in the future.

reputation making operators more reluctant to pay vendors high margins. By observing the development of commercial-off-the-shelf (COTS) based SDRs and the applicability of those being implemented in carrier grade networks telecom vendors can save substantial amounts of R&D expenditure. However, it should be recalled that while postponing resource commitments the competitors are gaining competitive edge through first-mover advantages.

To monitor the industry structure evolution telecom vendors should pay close attention to operator and internet service provider strategic movements related to service bundles and related strategic partnerships. For example, major internet service providers such as Google and Amazon should be observed in case of increased service bundling and their overall ability to offer the same basic communications services provided by MNOs today. Especially, close attention should be paid for access-device-service bundles already provided by Amazon's Kindle (see section 4.5.4). One such possibility could be that Google will begin to offer its Nexus One[39] mobile phone including access in a bundled package directly to end-users. Telecom vendors should also closely observe the operator "self-cannibalization" actions of moving towards more bit-pipe-oriented business models. One such example is 3 UK's X-series to provide subscribers with flat-rate data plans and devices with integrated Skype[40] application opening its network for internet players for service provisioning (3 UK, 2006). While the future of MNOs position in the mobile services ecosystem becomes clearer telecom vendors should not invest substantially in MNO-vertical service creation and enabling platforms. Instead, to lower risks of lost investments, telecom vendors should possibly source SDPs from other vendors until it can be more credibly seen whether MNOs have any role in subscriber QoE besides the access provisioning.

As a general guideline for a firm choosing "Preserve flexibility" strategy it is advised to closely observe competitor movements, especially strategic betting. Competitors' moves usually embody valuable information about industry's general evolution and make critical uncertainties clearer. With this strategic approach a firm should also pay attention to the organization's internal transformation capabilities. When industry uncertainties begin to unfold a firm should be able to deploy resources according to the selected strategy and related implementation lead times should be rather swift. The strategic implications for "Preserve flexibility" approach and its strengths and weaknesses are assessed in Table 12.

[39] http://www.google.com/phone/
[40] http://www.skype.com/

Table 12: Assessment of "Preserve flexibility" strategy

| | |
|---|---|
| **Strategic implications** | • Maintain competitive 3GPP solution portfolio with cautious investments and technology openness in mind<br>• Source WiMAX and Wi-Fi technologies<br>• Reduce the investments in comprehensive, MNO-vertical SDP development (rather outsource)<br>• Prepare the organization for agile adoption of new strategic approaches |
| **Strengths** | • Comprehensive mobile network technology solution portfolio with conservative investments<br>• Return on investment risks mitigated by reducing resources committed to solutions encompassing greater risks (risks related to added value for MNOs) |
| **Weaknesses** | • Overall first-mover advantages weakened in network and service layers<br>• Time and resources spent on organizational preparations to some extend wasted |

## *5.5 "Influence"*

"Influence" strategy aims to impact the causal factors behind the key industry uncertainties. When assessing "Influence" approach a firm should take a few key aspects into consideration. These factors introduced by Porter are listed briefly below.

1. What are the firm's chances to influence the causal factors behind scenarios
2. If possibilities to influence exist what are the costs or resources required
3. Balance between costs and competitive edge gained if influence pays off
4. Scenario probabilities

A great starting position exists for a telecom vendor to adopt "Influence" strategy. The fundamental idea is to choose the most beneficial future scenario and try to impact the course of industry evolution to that particular direction. As was discussed earlier (see section 5.2) the most feasible scenarios for telecom vendors were deemed to be the integrated access scenarios, especially the "Professional service vendors" scenario as the other scenario with integrated MBB access landscape - "Technology suppliers" scenario - was seen very unlikely to occur. Additionally, "Professional service vendors" scenario was considered to be rather probable future outcome. The most feasible

scenario being also likely probable gives an excellent starting point for the “Influence” approach. The “Influence” approach has similar aspects than the “Bet on the most probable scenario” strategy. The main difference is that when choosing “Influence” it is not explicitly expected that the wanted scenario occurs but resources are committed in order to make the scenario a reality. In terms of solution portfolio a telecom vendor would develop one that promotes operators to adapt a role of a sole connectivity provider or a “bit-pipe”. Below are listed the main solution portfolio areas to concentrate when trying to direct the industry evolution towards “Professional service vendor” scenario.

- Network operations outsourcing services and OSS integration to minimize the greatest source of operator OPEX
- Network optimization and revenue assurance services to leverage the existing infrastructure and ensure the absence of revenue leakages
- Low CAPEX, fast capacity expansion solutions, especially for local areas and indoor locations
- Security solutions for operators to enable secure connectivity provisioning for enterprises (cloud service enabling) and end-users (enabling diverse identity management (IDM) related opportunities such as mobile banking)
- Flat network architecture with HSPA+ and LTE solutions

Based on expert interviews the area where telecom vendors have a substantial opportunity of influence is the future mobile network technologies (both radio and core networks). The network technology development today determines the future technology landscape being a critical causal factor of the evolution of access fragmentation. Telecom vendors should strongly promote 3GPP over IEEE technologies and possibly drop IEEE solutions out from the company product portfolio. This choice could be promoted publicly with announcements to impact operator decisions about technological choices. High promotion of 3GPP femtocell technologies is also required to maintain the access landscape integrated. One of the biggest barriers for large scale femtocell market growth is the international data roaming pricing. Today consumers are afraid of high data bills when travelling which is keeping them from using mobile data connection abroad. This indicates lost revenues for operators when traveling customers are considered. For example, at airports, hotels, enterprise premises and cafeterias there already exists Wi-Fi infrastructure offering end-users

internet access practically free of charge. With growing mobile data usage in mind – especially in indoor locations – operators should collaborate with each other, telecom vendors and regulatory more intensively to erase this barrier. Fast and cost-efficient 3GPP femtocell roll-outs in collaboration with MNOs, vendors and regulatory should be implemented starting from above mentioned hotspot locations to lower the end-user fear of expensive data roaming bills and offer them single-radio-technology for ubiquitous mobile broadband access globally.

Another critical factor behind the future of mobile broadband access landscape is the development of spectrum regulation. Best scenario for MNOs and telecom vendors consists of a centralized spectrum regulation environment, where governments hold spectrum auctions mostly for a few incumbent MNOs to purchase a spectrum license for a rather long period of time. In this model the incumbent MNOs owning the licenses hold key positions in the business ecosystem at the same time promoting 3GPP cellular technologies provided mainly by traditional telecom vendors. To influence spectrum regulation evolution telecom vendors together with MNOs should influence ministries of communications nationally to maintain spectrum regulation central. Reasoning behind these proposals are MNOs substantial investments in spectrum licenses and mobile infrastructure operating on these licensed spectrum bands. One of the critical aspects is to ensure that governments are not forced to promote competition and localize spectrum management which is more likely to happen if MNOs struggle to provide efficient wireless capacity locally and indoor locations. Influencing spectrum regulation thus promotes the 3GPP femtocell technology development in order to provide ways of using existing licensed bands to provide better indoor coverage and capacity for mobile broadband if wide area technologies won't scale.

Yet another influencing possibility to keep the access more integrated is the vendor-specific LTE standardization, especially the interface between LTE equipment (radio base stations, network gateways and network servers) and network management systems[41]. Major telecom vendors could come up with a common agreement of standardized ways for network elements to communicate with each other and management systems to drive the technological evolution of mobile networks to the direction which is beneficial to the MNO and telecom vendor stakeholder groups. This strategy would also keep IP-networking and major platform vendors from entering the core telecom vendor market unexpectedly.

One critical causal factor behind industry structure evolution was seen to be mobile applications market. However, traditional telecom vendors have only a marginal impact on the application and

[41] The interface between network elements and management systems is sometimes called the North-Bound Interface (NBI).

services market in today's internet-led business ecosystem. In general, no clear reasons are seen why content, applications or services should be delivered via MNOs as all the available value added services are already accessible today with a simple internet connection. As this kind of evolution is expected to be inevitable telecom vendors should promote it early and offer operators solutions for adapting a "service enabler" role. By abandoning holistic SDP portfolios telecom vendors could concentrate on providing operators efficient asset exposure and billing platforms (similarly to the "bet on the most probable scenario" strategy) to enable collaboration with variety of existing large internet service providers. In this way MNOs and telecom vendors could more efficiently use their existing resources and gain access to service and application revenues. The strategic implications for "Influence" approach and its strengths and weaknesses are assessed in Table 13.

Table 13: Assessment of "Influence" strategy

| | |
|---|---|
| **Strategic implications** | • Promoting and developing 3GPP solutions only, including 3GPP femtocell technologies<br>• Try to influence data roaming regulation and collaboration between MNOs in terms of shared 3GPP femtocell deployments<br>• Collaborate with MNOs to ensure that regulators are not forced to promote competition (e.g. localization of spectrum management)<br>• Collaborate with other telecom vendors to agree common interfaces between network elements in LTE (and beyond) technologies<br>• Promote the role of operators being service enablers with asset exposure and billing platform solutions |
| **Strengths** | • Targeted scenario is backed by feasibility and probability<br>• Current strategy and position of a traditional telecom vendor is not far away from the ideal strategy for "Professional service vendors" scenario<br>• If successful, end-users could be provided with ubiquitous access via a single technology family (3GPP) provided mainly by MNOs and traditional telecom vendors |
| **Weaknesses** | • Common agreement of LTE NE interfaces could trigger increased competition between established telecom vendors and accelerate network equipment price erosion<br>• No solution portfolio addressing WiMAX or Wi-Fi operators |

# 6 Conclusions

In this chapter the key results of the research are first summarized after which the results are assessed in terms of reliability, validity and relevance. Then, proposals for exploitation of the results are made and the chapter is concluded with a discussion of possible subjects for future research.

## *6.1 Results*

The author's main contribution during the research can be realized in two main chapters of the thesis. As a remainder the research question was two-fold; (1) What are the different possible value configurations between operators and vendors in the future (2015) and (2) how should telecom infrastructure equipment vendors formulate their strategy to best cope with them? Results to the first question were obtained in the scenario construction chapter (see chapter 4) where key trends and uncertainties shaping mobile communications industry were studied utilizing interviews and PEST analysis. The chapter continued as four possible value configuration outcomes between key stakeholder groups were developed following Schoemaker's scenario construction process. After the scenarios were developed and assessed the second part of the research question was addressed by introducing strategic implications for telecom vendors (see chapter 5). Five strategic approaches by Porter (see section 3.3.2) were assessed in terms of strategic implications and their strengths and weaknesses.

One of the key findings during the entire research was the dramatic change of vendor environment in mobile communications industry. This was realized during the whole process but especially in the industry background section (see chapter 2) where the changing telecom vendor internal value configurations and the shift from large-scale system roll-outs to software and service oriented business models are discussed. As traditionally strong-positioned hardware is losing its power as a part of vendor solutions, telecom vendors must be able to adapt to the new rules of business by transforming internally to better support software and services business models and customer needs flexibly.

The key uncertainties that formed the boundary mobile communication industry scenarios were partly based on study by Smura and Sorri (2009); (1) "the verticality of industry structure" described the degree to which mobile access and services are bundled together and (2) "the fragmentation of mobile broadband access landscape" described the fragmentation of mobile access in terms of the number of technologies and operators involved. As a result four different future

scenarios were developed two of which were considered to be more conservative (integrated access) and two of which have more progressive characteristics (fragmented access) considering the five year time-frame. “Technology suppliers” scenario presents a value system where incumbent MNOs and their traditional vendors dominate the industry. In “Professional service vendors” traditional telecom vendors maintain rather powerful position as direct vendors for MNOs whose main objective is to leverage their existing assets by minimizing both OPEX and CAPEX. In “Networks as platforms” scenario the mobile broadband access landscape is extremely heterogeneous and the decrease of telecom-specificity of networking systems has made it possible for major hardware and software platform providers to enter the telecom equipment market more intensively. “Vendors as operators” scenario presents a value system where major internet players extend their power position pushing operators and vendors one tier away from the end-user by bundling MBB access and services. In this scenario telecom vendors have adapted a role of outsourcing partner and thus operate the majority of communications networks globally.

Strategic implications for telecom vendors were discussed based on five different strategic approaches. “Bet on the most probable scenario” approach suggested committing resources for gaining a competitive edge in “Professional service vendors” scenario. This approach suggested aiming for low TCO solutions having a substantial weight on 3GPP technologies, decreasing resources in operator own content and service creation platform development and promote professional service portfolios and related industry success stories. “Bet on the best scenario” approach defined strategic implications for betting for “Technology suppliers” scenario suggesting increased resource commitments to provide MNOs with platforms for opening own application stores and managing third party content and service environments. “Hedge” approach aimed to minimize the maximum losses by supporting a wide range of technology and service portfolios. “Preserve flexibility” strategy involved sourcing of technologies with questionable future success and preparing the organization for agile adoption of new strategic approaches. “Influence” approach suggested publicly promoting 3GPP technology portfolio over other possible substitute technologies and collaborating with regulatory and incumbent MNOs to drive for centralized and technology-tied spectrum regulation.

## *6.2 Discussion*

Usually Schoemaker’s scenario planning process is complemented with brainstorming sessions during the gathering process of market forces in order to get broad view of relevant and important factors shaping the future. During the thesis, however, there was no opportunity to arrange a

brainstorming session due to a variety of reasons. Although, brainstorming sessions were not held literature study and industry expert interviews were conducted to gather and assess a broad set of market forces.

One aspect that frequently came up during the research was the geographical scope of scenario description process. The fundamental idea from the beginning of the thesis was to keep the thesis scope rather broad in order to get a holistic view of different future industry evolution possibilities. However, this broad scope definition brought some bias to discussion sessions with industry expertise as mobile broadband access and services markets were considered substantially inconsistent in different geographical locations (e.g. Europe, U.S. and China). It should be remembered that this is also an advantage of having a broad scope because different scenarios can be viewed as different geographical markets. For example, vertical scenarios could represent mobile industry ecosystems in Japan and China while in Europe the business environment is much more horizontal. The scenarios can aid managers to see the global markets as a combination of many distinct scenarios rather than as one global scenario implying that telecom vendors should have a combinations or sequences of different strategies[42].

Probably the most important contribution of the thesis is to bring a new perspective to the traditional approach of preparing for the future. The established telecom vendors have decades of experience in telecommunications R&D which has been mostly internally-oriented and hardware-centric. Today, as the mobile communications industry is experiencing radical changes in both end-user and mobile infrastructure provisioning sectors managers of telecom vendor organizations should be capable of changing their conventional attitudes and broaden their view of possible industry evolution directions.

## *6.3 Future research*

As discussed above the inconsistency of mobile services and access markets in different geographical locations was frequently brought up during the research. During the thesis a rather broad view of the mobile communications industry and possible value systems from the global view point was obtained. In the future the scope could be narrowed down to study the industry evolution in smaller geographical markets by concentrating certain types of operators and technological landscapes.

[42] After introducing five strategies under industry uncertainty Porter (1985) presents ways of and reasoning behind combining and sequencing different strategic approaches.

As was mentioned in chapter 3 the last two steps of Schoemaker's scenario planning process were left out from the thesis scope. These last steps involve quantitative analysis which can improve the concreteness of constructed qualitative scenarios. One approach could be to apply system dynamics modeling to study the dynamics of the current and future mobile communications industry. System dynamics models could be created for different scenarios individually to study the most powerful feedback loops present. Another possibility is to construct a broad system dynamics model that incorporates all the constructed scenarios in order to study how transitions between scenarios could occur and which forces and feedback loops drive these possible transitions. This industry cycle of vertical and horizontal industry structures and integrated and modularized technical architectures is widely referred as the double helix theory (Fine, 2000).

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