UNIVERSITY OF TAMPERE
Department of Management Studies

A CASE STUDY OF DISRUPTIVE FORCES IN THE OPERATIONS SUPPORT SYSTEMS INDUSTRY

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ABSTRACT

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Suddenly there is a disruption in the industry. Strong, ruling enterprises collapse and newcomers take over. Enormous wins and losses are at stake. Could this have been foreseen? Clayton M. Christensen and co-workers (1997, 2003, 2004) have recently significantly improved the theories for anticipating radical industry changes.

In this study the new disruption theories, related to industry in general, have been adapted to the software-oriented Operations Support Systems (OSS) industry and the theoretical model has been further improved through in-depth interviews with nine carefully selected OSS industry leaders, covering all the relevant points of view.

The major disruptive forces of the OSS industry during 2007-2010 will be *Decreasing Development Budget* (high probability), *Convergence of Services* (high probability), *OSS Cost Ratio* (medium probability), *Layering of Communications* (medium probability), *Integration Cost* (low probability) and *Flexible, Modular OSS* (low probability). The disruptive forces that will have a medium impact will be the increased *Respect for End-Users* and the continuation of *Network Management Outsourcing*.

The only major stabilizing force is *Weak Regulation* and standardization, but even that can be overcome by de facto standards. *Missing Leadership*, *Tailoring for CSPs* (Communication Service Provider), *CSPs' Organizational Inertia* and *Replacement Costs* will have medium stabilizing impact on the industry.

As a conclusion, the OSS industry will experience several disruptions during 2007-2010. The disruption theories fit partially to this software-oriented, derived industry.

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Äkkiä toimialan rakenne muuttuu. Vahvat, hallitsevat yritykset romahtavat ja uudet tulokkaat astuvat valtaan. Valtavat sijoitukset ovat pelissä. Olisiko tämän muutoksen voinut ennustaa? Viime aikoina erityisesti Clayton M. Christensen kollegoineen (1997, 2003, 2004) on huomattavasti parantanut rakennemuutosten ennustamisteorioita.

Tässä tutkimuksessa uudet rakennemuutosteoriat sovitetaan ohjelmistopainotteiseen OSS-teollisuuteen, ja syntynyttä teoreettista mallia parannetaan syvähaastattelemalla yhdeksän huolellisesti valittua johtajatason teollisuustoimijaa.

OSS-teollisuuden vahvat disruptiiviset voimat 2007–2010 tulevat olemaan *tuotekehitys-varojen väheneminen* (todennäköisyys suuri), *tietoliikennepalvelujen yhdentyminen* (suuri), suhteellisten *OSS-kustannusten nousu* (kohtalainen), *tietoliikennejärjestelmien kerrostuminen* (kohtalainen), *integraatiokustannusten nousu* (pieni) ja *joustavan, modulaarisen OSS-järjestelmän synty* (pieni). Kohtalaisesti vaikuttavat *tietoliikennepalvelujen käyttäjien arvostus* ja *verkonhallintatyön ulkoistaminen*.

Ainoa vahva stabiloiva voima on *heikko sääntely ja standardointi*, joka sekin voidaan kiertää de facto -standardein. Alalta *puuttuva johtajuus*, *CSP:eille räätälöinti* ja *CSP:eiden sisäinen organisatorinen hitaus* sekä *muutoskustannukset* ovat toimialan kohtalaisia stabiloivia voimia.

OSS-teollisuudessa tapahtuu useita äkillisiä rakennemuutoksia 2007–2010. Yleinen teoria soveltuu osittain tähän ohjelmistopainotteiseen tietoliikenneteollisuuden osaan.

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1 INTRODUCTION

1.1 Disruption

Suddenly there is a radical change in the industry. Strong, ruling enterprises collapse and industry newcomers take over. Enormous wins and losses are at stake. Often these changes are related to advances in technology. According to Gary Hamel (2000, 5), in the twenty-first century the changes will be often discontinuous and abrupt, but why do some technology changes bring with them disruption and others do not?

After a quick glance, the industry disruptions might appear random. However, during the past years, Harvard Business School Professor Clayton M. Christensen and co-workers (1997, 2003, 2004), have developed theories to foresee disruptions caused by innovations. The purpose of this study is to understand if these theories fit into the Operations Support Systems (OSS), which is a software system used to manage communications infrastructure. Especially, what are the forces causing and preventing disruption, and is the OSS industry likely to continue steadily or is it heading towards a major turmoil?

1.2 Room for Change

During 2006, the Communication Service Providers (CSPs) were estimated to have spent 4.0 billion (10^9) euros on external OSS systems and a disproportionate 12.9 billion euros on external OSS integration services (Operations Support Systems 2000-2010, 2006, Sheet Worldwide).

As will be shown in the Section *3.4 State of OSS* Industry, the industry is missing a clear, established architecture. In addition, there is no OSS vendor in the market leader position (OSS Market Perception Study 2005, 8). Regardless of the ever ongoing inflow of new communication technologies, CSPs encounter fierce competition and the Network Equipment Providers (NEPs) are tumbling into a mature business environment. A very interesting question for anyone active in the OSS industry today is, will there be a disruption and what might cause it?

1.3 Theoretical Framework

This study is based on Christensen's (1997) work on the development of disruption theory. He started by analyzing situations where new technologies dramatically changed the relative positions of companies. The next step was to create a theory for the sustainment of successful growth with Michael R. Raynor (2003). Especially useful for this study is his latest work with Scott D. Anthony and Erik A. Roth (2004), on the creation of theory for forecasting of disruptions.

Geoffrey A. Moore (2006) has developed a theory concerning the constant evolution of industries and the factors forcing companies to move forward in the value chain. This work nicely complements the theory of Christensen and his companions.

The industry analysis is based on widely recognized work of Michael E. Porter (1998). Finally, a few software industry specific factors are included into the theory based on several authors, but especially important is the idea of platform leadership presented by Annabelle Gawer and Michael A. Cusumano (2002).

1.4 Scope and Purpose

1.4.1 Time Period

In the year 2000, there was an immense hype about third-generation mobile communications (Ojanperä, Tero & Prasad, Ramjee (editors) 1998, 12) and the opportunities were compared to the permission to print money. For example, 45 billion euros were spent in Germany and 33 billion euros in the UK on license auctions (Scramble for licenses [homepage on the Internet] 2001. Available from: http://news.bbc.co.uk/2/hi/business/1272501.stm).

Only three years later, the NEPs were on their knees. In order to return to profitability, the market leader, Ericsson, announced in July 2003 as a target to cut its workforce to

47 000 during 2004 from the 105 000 employees that were employed in the end of 2000 (Ericsson Annual Report 2000, 6; Ericsson Second Quarter Report 2003, 3).

Yet three years later, the situation looks again different. The total telecom market grew 9% on 2005 and an over 5% healthy growth is estimated for 2006 and 2007, followed by declining but positive development during 2008-2010 (Global Telecommunications Market Take 2006b, 5).

As seen above, the situations change rapidly in the parent industry of OSS and, therefore, forecasts for more than 3-4 years are not meaningful. On the other hand, major change takes easily 3-4 years as the upgrade process of these giant software systems is long. One year to develop a new software release, one year to distribute it to the customers and one year for the last customer to roll it out can be considered rapid, if the question is about a global major OSS system upgrade. Based on these opposite factors the focus period of the study is set to the next four years.

T The time span of the study is 2007-2010.

The focus is to study issues active in the industry, i.e. what NEPs and Independent OSS Vendors (IOV) are marketing, developing and selling and what the CSPs are studying, piloting and purchasing. The actual subscribers of the communication services might experience some of these things years later, if ever.

1.4.2 Systems in Focus

The OSS systems developed for GSM (Global System for Mobile Communications) are quite similar to the OSS systems developed to support other mobile communication technologies, and even quite similar to the OSS systems developed for any communication systems like fixed or satellite communications. Therefore, the barrier to use OSS systems developed for one communication technology to manage another is low, and an industry study must cover all the OSS systems created to support communications technologies. However, the main focus of this study is on the three economically most significant technologies, i.e. mobile, fixed and broadband communications.

There are two major systems that some industry players categorize as OSS and others that are not. These are the billing systems and systems developed to manage the end user equipment, for example, the Equipment Identity Register (EIR) of GSM. Both of these are excluded in the theory phase, as there is no reason to expect them to be more or less disruptive. However, in the empirical phase, also findings related to these are noted.

In order to be open for future development, the technical scope covers theoretical things that could be done with OSS type of software as well as the capabilities that are existing today.

1.4.3 Purpose of Study

The aim is to develop a theoretical framework for disruptions in the OSS industry, evaluate and develop it further through interviews with carefully selected industry leaders. In the form of research questions, the purpose of this study can be formulated as follows:

Q1 Is there going to be disruptions in the OSS industry during 2007-2010?
Q2 What is causing or preventing these disruptions?
Q3 Are the generic industry disruption theories applicable for OSS?

1.5 Structure and Methodology

The disruption theories are complemented and adapted to suit the business-to-business, software-oriented OSS environment in Chapter 2. The context, structure and status of the OSS industry are discussed in Chapter 3. These chapters together lead to the theoretical model for disruptive and stabilizing forces in the OSS industry presented in Section 3.7.

The methodology of this *explanatory case study*, selection of the interviewees and data collection in the empirical phase are discussed in Chapter 4. It includes also the reliability and validity analysis of the research.

The essential interview findings and the conclusions for each disruptive and stabilizing force are presented in Chapter 5. Chapter 6 summarizes the study and presents the developed model for disruptive and stabilizing forces in the OSS industry in Section 6.2. The reasons for the differences between the theoretical and the developed model and the possible areas for further study are also discussed here.

Chapter 7 lists the used references. The communications technology specific terms and abbreviations are gathered to the Chapter 8.

All the presented views and opinions are those of the author and do not necessarily reflect the views of his employer.

2 INDUSTRY DISRUPTION THEORY

The focus of this study is on radical and revolutionary, i.e. disruptive, industry changes that inevitably change the structure of the value chain and proceed considerably rapidly once they have started to diffuse.

Christensen, Anthony and Roth (2004) have developed a process to predict industry change. The focus is to foresee disruptive innovation and evaluate the entrant's capabilities to drive that innovation through and to radically change the industry's prevailing structure. The key components of the process are depicted in Figure 1.

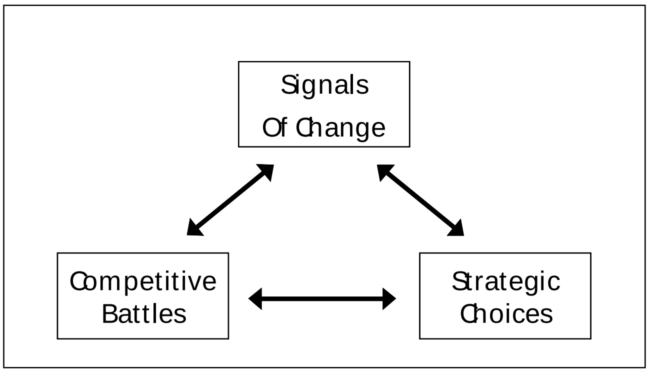

Figure 1 Process to Predict Industry Change (Christensen & al 2004, xxxiii)

The first step in the process is to look for the *signals of change* by analyzing the customers of the industry. The key question is what customer groups are not optimally served by the industry at the moment, i.e. this is where there is a natural demand for innovation. (Christensen & al 2004, 3-5)

The second step is to analyze the participants of the *competitive battles* arising around disruptive innovations. Are the powerful incumbents or the new entrants fighting for a break-through better prepared for the battle? What characteristics of these companies should be especially looked at? (Christensen & al 2004, 29-31)

The final step is to pay attention to the *strategic choices* the companies have to make. What are the decisions that particularly impact their likelihood to succeed (Christensen

& al 2004, 53-55)? How can it be estimated whether the companies are likely to make these decisions correctly in order to win this battle? Let's start building the theoretical framework by looking at innovations.

2.1 Disruptive Innovation Theory

Innovations can be divided to three types. A *sustaining innovation* means improving something that exists to something better. For example, developing a longer lasting battery for a mobile phone is a sustaining innovation. The established companies are typically better in driving this evolution by improving existing products on *dimensions historically valued by customers*. Their power, accumulated know-how and established customer network give them far better position to do this. (Christensen 1997, xv-xvii)

A *low-end disruptive innovation* means offering to customers, for whom current products are "too good", a low-priced, relatively straightforward product (Christensen & Raynor 2003, 46-49). The natural tendency of the existing companies to constantly further develop their products, tends to create customer segments who do not need or at least do not fully value everything included to a product. For example, Dell's innovation to cut the wholesale and dealer networks from the value chain and to start to sell directly to the end customers was a low-end disruptive innovation (Moore 2006, 69).

The second type, a *new-market disruptive innovation* can take place when the usage of the existing products requires either deep expertise or great wealth. The innovation is basically about making an existing product available to nonconsumers (Christensen & Raynor 2003, 45-46). For example, the telephone innovation of Alexander Graham Bell made it possible for consumers to make calls by themselves without the need to learn the skills to operate a telegraph system or to have a person to operate the system for them (Christensen & al 2004, xxii-xxvii).

A common thing for the disruptive innovations is that they bring in a new value proposition (Christensen 1997, xv). They either create new markets or reshape the existing markets.

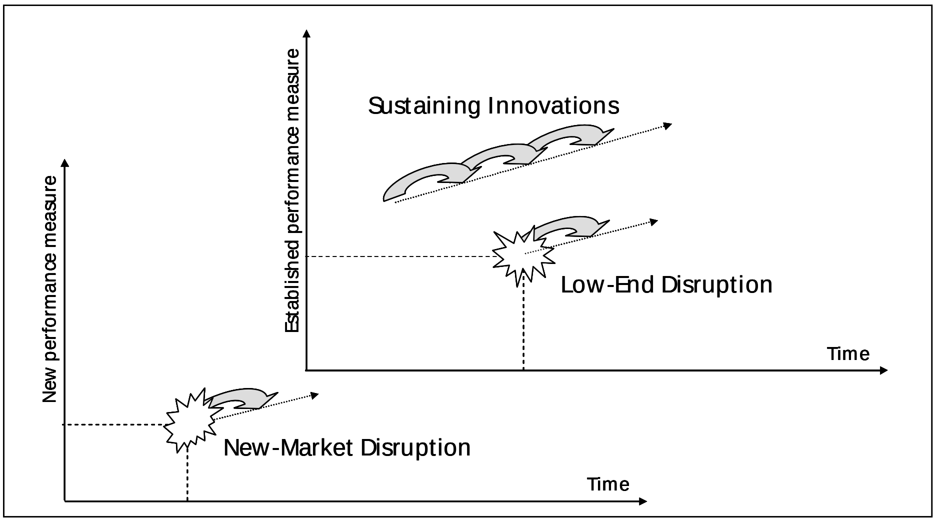

Figure 2 Innovation Types According to Christensen & Al

The three innovation types as proposed by Christensen and co-workers (2004, xvi) are depicted in Figure 2. If they are vital enough to support a business, then both types of disruptive innovations will also start a series of sustaining innovations.

The previously described two disruptive innovation types cover the vast majority of the radical innovation related industry changes, but in order to complete the picture one additional type should be added. Let's refer to this as a *unique disruptive innovation* when something *totally new for the mankind* is invented. For example, when Leonardo da Vinci, around the end of the 15^{th} century, invented the airplane (TEK 1981, part 4, 87), it was a unique disruptive innovation. It was not a lower price, i.e. a low-end disruption, and it was not something requiring traditionally deep expertise or great wealth for new consumers, i.e. a new-market disruption.

The unique disruptive innovations are by nature very rare, and as none is expected in the OSS industry, these are excluded from the rest of the study.

2.2 Resources, Processes, and Values Theory

Christensen and Raynor (2003, 177-211) have split the ambiguous concept of the capabilities of a company to three sets of factors. The *resources* are the tangible assets a company has including its people, equipment, information, intellectual property rights, brands, financial reserves and relationships with the customers, distributors and suppliers. As a set of factors the resources are the easiest to evaluate and also the most flexible ones, i.e. easiest to sell and buy, or hire and fire.

The *processes* describe how a company transforms its inputs to outputs of increased value. They tell not only the ways products are developed and manufactured, distributed and so on, but also how market information is collected, budgets formulated, employees rewarded and decisions made. Some of the processes are formal and described precisely in written form, but many of the important processes are informal, i.e. they are ways of working which people have adopted.

The processes are much more difficult to evaluate for an outsider than the resources of a company. Especially, the processes supporting investment decisions including the market research process, the process to translate market outlook to financial projections, and the process to plan, negotiate, approve and change budgets are often informal and/or classified. Therefore, these processes that are vital to the evaluation of the company's ability to drive through an industry disruption are difficult to study directly.

However, there is a very natural tendency to develop processes when they are actually used. That is, when a group of employees use a process they tend to refine and improve it in order to make performing of repetitious task more efficient. Based on this, in estimating a company's processes regarding driving through something, it is worthwhile to look into the past. If the company has wrestled with similar challenges in the past, the likelihood of the existence of suitable processes is high. And vice versa, if for example, a company has no experience in creating and competing on markets that do not yet exist, it is very likely that it is also missing an efficient process for it, and the first attempt in this area will involve a substantial amount of initial problems.

The previous example also forms the first step in explaining why incumbents have difficulties with disruptions. Both low-end and new-market disruptions require new and different ways of working, i.e. new processes. The established companies who try to solve these problems with their existing processes are slow movers in comparison to the entrants who either have to develop new processes anyway, or who even might already have experience in working in similar situations in the other industries. According to

Vijay Govindarajan and Chris Trimble (2005, 98) incumbents suffer from several learning disabilities compared to newcomers.

The third set of factors related to the capabilities of a company is formed by the *values*. The values guide the employees of a company in their decisions: which customer to prioritize and call to, which existing products to push on the market, whether a new product is attractive or marginal, which departments are allowed to hire and so on. These prioritization decisions are made daily by all the employees on the organizational layers from top to bottom. Over time, the shared values of a company impact strongly to its financial results. This is also why successful senior executives spend a lot time articulating the company's values and communicating its strategies.

While the resources and processes enable companies to do things, the values have also a limiting role, what a company should not do. For example, if a company has enjoyed over 40% gross margins and adjusted its structure to that, it is very difficult for it to enter into a below 20% gross margin business. Similarly, the current highest revenue and highest profit lines of business tend to get the highest priority, the biggest advertising budgets, and the best new talent and so on. Also, because of the endless opportunities for sustaining innovations, the current major business lines tend to attract a lot R&D focus. In the short term, a 10% improvement of the high likelihood to succeed in a major business, are both more profitable and has a lower risk stake than an investment into a new, unknown venture.

The second step explaining the difficulties that incumbents have with disruptions is based on the values. The existing businesses of an incumbent get inevitably a lion's share of management attention and resources whereas for an entrant its disruptive move might be a win or die type of an initiative getting all the attention and resources.

2.3 Value Chain Evolution Theory

Based on Geoffrey A. Moore (2006, 29-36), the business architecture of a company that is efficient in dealing with complex problems and developing individual solutions is very different to the business architecture of a company that is efficient in volume operations. And because efficiency requires full adaptation of the company to the selected model, it is in practice impossible for one company to be successful in both environments (Figure 3).

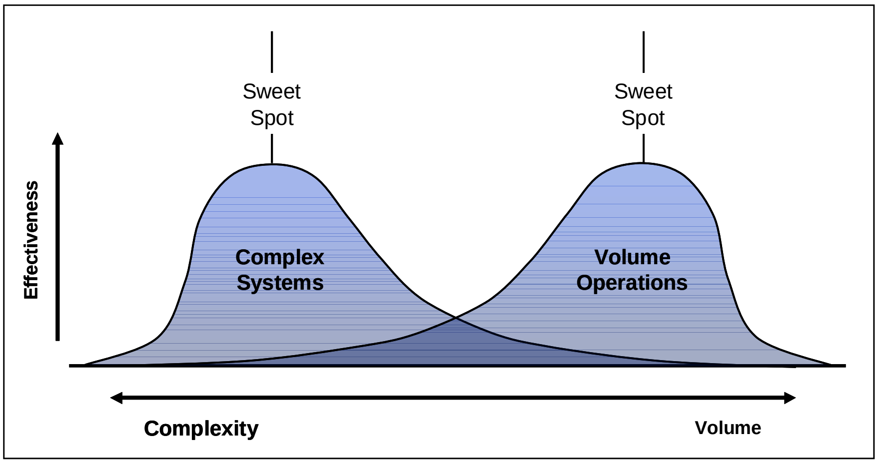

Figure 3 Complex Systems Versus Volume Operations (Moore 2006, 30)

During time, complex processes requiring initially expertise and manual work tend to become more repetitive. In this phase, it is possible to develop software to help and automate these tasks. Companies which are good in volume operations replace companies optimized for complex systems, who must move upwards in the value chain in order to survive.

For example, in the early days of GSM, the optimization of the radio network was a special task for a few experts who could understand the complex system. Today, optimization tools can fine tune a GSM network in a moment to a certain level which corresponds to months of work by a group of experts, but in the optimization of 3G radio networks the expertise of the work of individuals still beats the expertise contained within the software functionality. According to Moore (2006, 232-233) core shifts to contexts, and the companies that are willing to prosper must shift their focus accordingly upwards in the value chain.

2.4 Competitive Battles

According to Porter (1998, 35), there are only three generic strategies for success in emerging competitive battles: overall cost leadership, differentiation and focus. Christensen and co-workers (2004, 30) refer to Porter, but omit focus. Probably for them, focus which is on a particular buyer, on a segment of a product line or on a geographical market is only a way to achieve either cost leadership or differentiation benefits in that focused domain. In this study, the list of the three generic strategies by Porter is used as a tool to evaluate possible strengths and weaknesses of a company.

2.5 Software Industry Specific Elements

2.5.1 Incremental Cost

Because software is immaterial, most of the development costs cannot be recovered after the first copy of a product has been developed (Shapiro, Carl & Varian Hal R. 1999, 22). In a business-to-business environment with large domain-specific software systems the reproduction, i.e. incremental costs of producing additional copies can be treated as zero as they are irrelevant.

On a market of limited number of CSPs as customers, the zero incremental costs means that each won deal is a good one if it does not impact the value received from the other customers (Thomas T. Nagle & Reed K. Holden 2002, 16). In practice, the competitors' willingness to match price cuts and the information flowing between the CSPs make tough price war an unprofitable approach, but selling software at significantly lower price to the CSPs on geographical areas lagging behind in the technology development is possible.

2.5.2 Cost of Unused Functionality

The zero incremental costs make it easy to distribute full blown versions with extensive functionality, even if a customer has purchased only part of the functionality. In fact, this kind of an approach may help the software developer to keep the number of different versions under control. The only short-term worry is not to ship for free certain functionality that a specific customer might be willing to purchase later.

On the customer side the situation is different. Although delivering extra functionality does not sound like a problem, it might cause costs in the form of additional integration, testing and maintenance effort or increased consumption of processing capacity. In addition, the customer's internal processes might get too complicated if the personnel are using several different tools for a task instead of one centrally selected and purchased, official tool.

2.5.3 Importance of Architecture

When industries evolve, firms tend to specialize to develop certain components and the industry gets de-integrated. Innovation can happen on modules and the overall system benefits from the combined innovation power of the companies. (Gawer & Cusumano 2002, 4-7)

There is a strong incentive to co-operate because an improved system offering increases the size of the pie for every company involved. However, this is possible only if the companies can agree an overall architecture splitting the system to modules, and specifying the interfaces between the modules. (Gawer & Cusumano 2002, 6-10)

If an industry cannot agree on a compatible architecture, it leads to a situation where the same problems are solved several times in parallel, and a customer cannot compose its system from the best modules, but has to select one combination of modules that interact together. Due to the missing reuse, the overall industry efficiency will be low and the proportionate cost of integration high.

2.5.4 The Levels of Openness

If the interfaces are open, i.e. the specifications are available to anyone; it is an invitation that attracts more companies to work around the system. Non-distribution of the specifications, i.e. keeping the interfaces closed protects the business to the benefit of the selected partners, but also limits the innovation potential and gives a less competitive technology image to the customers.

Messerschmitt, David G. & Szyperski, Clemens (2003, 232) define an interface open as an industry standard when its 1) specification is commonly agreed upon, 2) precisely and completely defined, and 3) well documented so that any company is free to implement it. As an example they refer to the USB interface of the personal computers.

The GNU project's definition for free software (What is Free Software? [homepage on the Internet] c1996. Available from: http://wwww.gnu.org) can be considered as one definition for extreme openness. In addition to free usage it includes freedom 1) to study how the program works, 2) to redistribute copies, and 3) to improve the program. Access to the source code is a precondition for 1 and 3.

Shapiro, Carl & Varian, Hal R. (1999, 198) present the question of openness as a continuum where the selection of the correct level has a fundamental impact on the value of the technology to the company and to the industry (Figure 4).

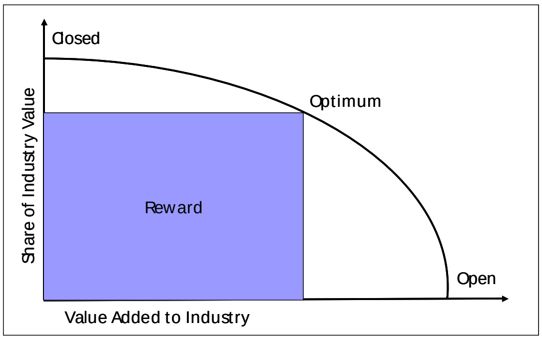

Figure 4 Optimum Openness According to Shapiro & Varian

As a summary, the openness of an interface is a complicated multidimensional continuum including consideration of the following:

- Are the interface specifications available?
- Who has the authority to release new specification versions?
- Is the information concerning upcoming interface changes available, freely and on an equal basis?
- Is the source code available?
- Can the source code be modified, can the modified code be distributed and who will be responsible to maintain the modified code?
- Are the new interface versions backward compatible, and for how long?
- Are there patents protecting the interface? On what terms are these licensed?

In the OSS environment, the related questions to essential interface openness, are does the openness fuel competition and does it provide compatibility?

2.5.5 OSS Middleware

In the communications industry, the competing NEPs each develop and maintain similar, an OSS specific middleware software layer that is telecom specific, but does not yet provide differentiation. The IOVs also implement, separately, similar functionalities.

Nokia has made an initiative to commonly define and create an OSS middleware layer that could provide, e.g. network element adaptation tools and basic functionalities to manage topology, faults and performance of the network (A new R&D Paradigm: Building OSS systems with standardized middleware 2004, 5).

Dittberner welcomes the initiative and says that in addition to the direct OPEX savings, an OSS middleware layer could ease the convergence of the communication technologies and adaptation of network elements and work as a step towards off-the-shelf OSS software. NEPs together have a credible experience to build OSS middleware, but the question is whether they will consider the risk of buying this functionality from a competitor. (Dittberner’s Examination of Nokia’s OSS Middleware Proposal 2005, 7)

2.6 Replacement Costs

When a software system is replaced, there is significant amount of possible costs, in addition to the pure cost of the software (Nagle & Holden 2002, 90-91). For example, costs related to the integration of the software to the other systems, cost of changing processes, training personnel and suffering from an interruption period during the upgrade and a period of reduced efficiency during the running-in of the new system. These costs, often referred to as switching costs, are called replacement costs in this study. They include also similar costs related to the upgrade of an existing system to a newer version from the same company.

2.7 Signals of Change

Based on the industry disruption theory discussed in this chapter, the following phenomena are candidates for disruptive and stabilizing forces in the OSS industry. As a writing convention, the names of the forces are written in *italics* in this report.

- Disruptive: *Overshot Customers* (Section 2.1)
- Disruptive: *Nonconsumers* (Section 2.1)
- Disruptive: *Repeated Middleware Effort* (Section 2.5.5)
- Stabilizing: *Replacement Costs* (Section 2.6)

3 INDUSTRY FRAMEWORK

The beginning of this chapter describes the context: the communications and the communication infrastructure industries. After that the history, current state and outlook of the OSS industry are discussed, which leads to theoretical model for disruptive and stabilizing forces in the Section 3.7.

3.1 Communications Industry

Serving the electrical communication needs of the slowly growing and economically strengthening global population is the basis of the communications industry. In this overview, the focus is on the three main segments that are fixed voice, fixed data, i.e. broadband and mobile communications. The assumption is that the other communication systems, including private mobile communications designed for the authorities like the police and the railways and satellite communications, can be excluded due to their remarkably smaller economical significance. The transport systems used to provide the above mentioned services are excluded due to their secondary nature.

3.1.1 Fixed Voice Communication Service Providers

Although according to International Telecommunications Union (ITU) (World Telecommunication Indicators 2005, 11) the number of fixed main telephone lines rose from 907 to 1 203 million from 1999 to 2004, the fixed voice market has been flat from economical point of view for a while. Actually, the market is expected on average to decline a bit over 5% yearly starting from 319 billion euros in 2004 to 247 billion euros in 2010 (Global Telecommunications Market Take 2006b, 22).

The fixed voice is in the decline of its life cycle with the figures above even accelerated by the inflation. Any funding to develop new things is very scarce and the operational focus is on running the companies in a very cost-efficient manner (Moore 2002, 192-194).

3.1.2 Mobile Communication Service Providers

Mobile communications development has been phenomenal during the past decade. In 2004, the global number of subscriptions rose by 27.5% (Table 1) (Global Mobile Market Forecast 2006, Sheet Total World). On many continental and national markets the peaks have been even more significant.

Mobile Subscriptions	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*CAGR*
Total Subscribers (m)	1416	1806	2212	2495	2694	2851	2971	3057	11.6%
Growth (%)	22.9%	27.5%	22.4%	12.8%	8.0%	5.8%	4.2%	2.9%	
Net Adds (m)	264	390	405	283	198	157	120	86	
Population (m)	6236	6300	6365	6432	6500	6570	6640	6712	1.1%
Penetration (%)	22.7%	28.7%	34.7%	38.8%	41.4%	43.4%	44.7%	45.5%	
ARPU (euro)	24.6	22.0	19.9	18.7	18.1	17.7	17.3	17.1	-5.1%
Total Revenue (mE)	378872	424821	480937	529508	563477	588092	605814	617111	7.2%
Growth (%)	11.0%	12.1%	13.2%	10.1%	6.4%	4.4%	3.0%	1.9%	

Table 1 Global Mobile Subscriptions Forecast according to the Yankee Group

When we look into the future, the annual subscription growth is estimated to drop to 2.9% by 2010. The average revenue per user (ARPU) will decline yearly over 5% due to the intensified competition driven by deregulation and the declining economical power of the additional subscribers. The highest growth countries with significant population will be India, Indonesia, Colombia and Peru with around 30% CAGR (Global Mobile Market Forecast 2006, country specific sheets) and the fastest growing area will be Middle East and Africa (Global Telecommunications Market Take 2006b, 4). Mobile communications, an annual business of 500 billion euros, is turning from fast growth to maturity.

Let's start the examination of the Mobile CSPs with the examination of the largest companies. The mobile network holding companies having more than 10 million subscribers are listed in the following table (Table 2) (World Cellular Investors 2006, Sheet Technology; Global Presence [homepage on the Internet] 2006. Available from: http://home.singtel.com/about_singtel/global_presence/overseas_investments/overseas_investments.asp). In order to utilize the cost benefits of global brand and marketing, the global companies must provide similar service everywhere, and in order to efficiently utilize central sourcing and global processes, they must focus on limited number of technologies and vendors.

Class	Holding Company	Subscribers (m)	Operating Countries	Number of Technologies	Largest Network with Majority Holding	Technology of the Largest Network
MR	China Mobile Ltd	195.7	1	1	China Mobile Ltd, China	GSM
G	Vodafone	176.9	35	5	Vodafone, Germany	GSM
MR	China Unicom	133.2	1	2	China Unicom, China	GSM
G	Telefonica O2	102.8	16	5	Telefonica Moviles Espana, Spain	GSM
G	America Movil	100.0	14	4	Telcel, Mexico	GSM
G	Deutsche Telekom	81.3	15	3	T-Mobile, Germany	GSM
G	France Telecom	73.9	13	3	Orange, France	GSM
G	MTS	62.0	5	3	MTS, Russia	GSM
MR*	NTT DoCoMo	53.1	3*	4	NTT DoCoMo, Japan	PCS
G	Telecom Italia	50.4	8	4	Telecom Italia Mobile, Italy	GSM
G	Telenor	47.8	16	4	Vimpelcom, Russia	GSM
MR	Sprint Nextel	44.9	7	2	Sprint Nextel, USA	CDMA
MR*	SBC Communications	41.8	3*	5	Cingular Wireless, USA	GSM
G	TeliaSonera	37.8	18	4	MegaFon, Russia	GSM
G	Verizon	37.7	6	5	Verizon Wireless, USA	CDMA
G	Singapore Telecom	31.1	7	5	Telkomsel, Indonesia	GSM
MR	Orascom	26.7	13	3	PMCL, Pakistan	GSM
MR	KDDI	25.6	3	3	KDDI, Japan	CDMA
MR	Temasek	24.6	10	6	SingTel, Various	GSM
MR	SK Telecom	19.9	3	2	SK Telecom, Korea	GSM
MR	MTN	19.9	11	2	MTN International, South Africa	CDMA
MR	KPN	19.3	3	2	E-Plus, Germany	GSM
MR	Portugal Telecom	16.6	9	5	TMN, Portugal	GSM
MR	Turkcell Holdings	16.5	7	2	Turkcell, Turkey	GSM
MR	Hutchison Whampoa	16.1	14	3	3, Italy	W-CDMA
MR	Telekom Malaysia	13.1	8	3	Celcom Group, Malaysia	GSM
MR	KTF	12.6	2	2	KTF, Korea	CDMA
MR	Alltel	12.5	6	5	Alltel, USA	CDMA
MR	TDC	11.2	9	3	Bité, Lithuania	GSM
MR	MTC	11.1	18	2	JMTS, Jordan	GSM
MR	Telstra	10.2	2	4	Telstra, Australia	GSM

* Minority holding in another holding company ignored.

Table 2 Mobile Network Holding Companies According to Informa

From the industry structure point of view, it is a different whether a company operates a single technology network in one country or whether it tries to efficiently manage multiple networks on different continents utilizing various different technologies. Although China, from the economical point of view, can be seen also as composed of 22 provinces with the population of each well exceeding small European countries, it is treated here as one country. Due to central administration and national mobile communication companies, the provinces are from the telecommunications point of view much more similar than 22 different countries.

Let's form a group called *Global Mobile CSPs* by selecting the companies operating at least in 5 countries, using at least 3 technologies and having more than 30 million subscribers. This leaves a group of 11 companies lead by Vodafone (Class *G* in the Table 2). A bit arbitrary drawing of the border line will not harm the study, if the actual company to represent the Global CSPs will be a company that clearly fulfills the criteria.

The other end of the CSP continuum is an independent CSP providing services only in one country. It can be agile and streamlined, but cannot enjoy any benefits of scale. Let’s name this group *Independent National CSPs.*

Between these two extremes there are companies that are significant in size and provide services either regionally or in the largest countries. These Regional Mega CSPs are fundamentally bigger than the Independent National CSPs, but do not have global reach and not all the multi-technology, multicultural and regulatory challenges of a truly global enterprise (started by Class *MR* in the Table 2).

The broadband wireless access is expected to soar from less than half a billion euros 2005 to over 3 billion euros by 2010 (Forecast, Broadband Access Systems 2006, Sheet Worldwide). This development will likely enable new device types and require specific network management attention, but will not even by the end of the period represent more than 0.5% of the total revenues of the mobile CSPs (Table 1).

3.1.3 Fixed Broadband Communication Service Providers

Broadband has quickly replaced the dial-up fixed data connections, and the global number of subscribers rose from 150 to 200 million during 2005 (Worldwide Broadband Services 2006, 2). Nevertheless, at the same time the competition, as well as the bundled and tiered services, drives the prices forcefully down (Worldwide Broadband Services 2006, 7-11). As the consequence of this and the general hardware price erosion, there is a strong pressure on the equipment prices and only the fiber access equipment market is expected to grow (Table 3) (Forecast, Broadband Access Systems 2006, Sheet Worldwide.

Broadband Access	2 004	2 005	2 006	2 007	2 008	2 009	2 010	CAGR 2006-2010
xDSL	4 583	4 872	4 912	4 550	4 177	3 907	3 572	-8%
Growth		6.3%	0.8%	-7.4%	-8.2%	-6.5%	-8.6%	
Fiber	2 811	3 556	4 156	4 665	4 555	4 688	5 458	7%
Growth		26.5%	16.9%	12.3%	-2.4%	2.9%	16.4%	
Other	3 769	3 664	3 439	3 170	2 938	2 599	2 392	-9%
Growth		-2.8%	-6.2%	-7.8%	-7.3%	-11.5%	-8.0%	
Total	11 163	12 092	12 506	12 385	11 670	11 193	11 423	0.4%
Growth		8.3%	3.4%	-1.0%	-5.8%	-4.1%	2.0%	

Table 3 Broadband Access Technology Forecast According to Gartner

For the CSPs, the challenge will be posed by the rapidly increasing number of terminal equipment at homes and offices that has to be delivered and maintained at a declining cost. As the providers of a multitude of communication services, they have also a strong image and customer pressure to provide at least decent quality and customer service also for the broadband access equipment. For the OSS, this means the quest to automate the management of the broadband access equipment and to do it with the existing personnel and systems. In this study, this pressure is included to the *Fixed Mobile Convergence*, which is a candidate for a disruptive force and is discussed next.

3.1.4 Fixed Mobile Convergence

The convergence of the fixed and mobile communications has been the next big thing in about ten years. Informa Telecoms & Media (Fixed Mobile Convergence 2006, 13-14) gives a persuasive list of reasons why the change threshold could be passed in the near future:

- The critical mass of fixed broadband service users is approaching; over 500 million subscribers estimated 2010.
- The acceptance of mobile virtual network operators (MVNO) is progressing through to their brand (e.g. Virgin), discount and niche market roles.
- Developing countries deploy directly mobile networks.
- The fixed CSPs on the developed markets are in financial straits due to the fixed mobile substitution and due to regulatory decreasing interconnection and roaming charges. They need a viable business model for the future.
- New entrants, especially content companies, are interested to penetrate the communications industry.
- For mobile terminal vendors the need for dual- or multimode handset would offer a major business opportunity to replace the existing terminals with more expensive and capable devices.

- The standardization towards IMS (IP Multimedia Subsystem) is proceeding successfully.

IMS is a system that is not dependent on the circuit-switched domain and can provide Internet services anywhere and at any time using cellular technologies (Camarillo, Gonzalo & Garcia-Martin Miguel A. 2004, 6-7). In convergence, IMS has an essential role as a technology that can be used to provide both fixed and mobile services (Leinonen, Anu 2006).

There is strong pressure to manage the converged network with one OSS approach and system for two reasons. First, from the cost point of view, the CSP is likely to use one combined team to manage the whole network. Second, the CSPs will very probably try to optimize the overall system and share network resources between the delivered services, which would be naturally easier with one combined OSS than with several parallel systems.

3.2 Communications Infrastructure Industry

Gartner (Forecast, Carrier Network Infrastructure 2006, Table 1-1) forecasts 2.2% cumulative annual growth in the global communications infrastructure business 2006-2010 which hardly beats the inflation. Japanese market is expected to decline (-6.5% CAGR) but otherwise the Asia Pacific will grow (7.5%) followed by the Latin America (4.3%); the other regions are expected to have a flat growth rate (Forecast, Carrier Network Infrastructure 2006, Table 2-1).

The communications infrastructure industry is an oligopoly. The top five NEPs acquired over 80% of the 177 mobile network infrastructure contracts awarded 2Q2006 and only ten got more than one contract (Mobile Network Infrastructure Contracts 2006, Sheet All_Contracts_Awarded). The maturing of the communications has intensified the cost focus on the infrastructure market. This with the economies of scale related to significant R&D, manufacturing and customer support costs typical in this industry have started the consolidations, the three most important of which are listed below:

- The acquisition of Marconi by Ericsson announced in October 2005 (Ericsson to acquire key assets of Marconi [homepage on the Internet] 2005. Available

from: http://www.ericsson.com/ericsson/press/releases/old/20051025-080124.html)
- The merger of Lucent and Alcatel announced in April 2006 (Lucent, Alcatel Finalize Merger [homepage on the Internet] 2006. Available from http://www.internetnews.com/infra/article.php/3596001)
- The merger of Nokia and Siemens announced in June 2006 (Nokia and Siemens in network deal [homepage on the Internet] 2006. Available from http://news.bbc.co.uk/1/hi/business/5093536.stm)

For OSS, this *Maturation of Communications* means increased pressure on the development budget and quest for more cost efficient operability solutions. The consolidations might also lead to harmonization of the OSS due to the decreasing number of equipment vendors on the market.

3.3 Birth of OSS Industry

In the early days, the operation and maintenance of telecom equipment was performed locally. There was an operator sitting next to a central switch or traveling to take care of possible remote equipment. As the communication systems have developed, the amount of equipment, the complexity of the systems and the quantity of management information have all exploded. (Mouly, Michel & Pautet, Marie-Bernadette 1992, 105-106)

In order to tackle the ever-increasing complexity, in the search for cost-effectiveness and in order to centralize the management of a communication network the Telecommunication Standardization Sector of the ITU (ITU-T) has recommended the principles for the Telecommunications Management Network (TMN) (ITU-T Recommendation M.3010, 2000). Appendix 1 contains a non-exclusive list of entities that can be managed by a TMN.

GSM is only one communication system where the TMN principles could have been adopted. However, the complexity jump from the previous analog mobile communication systems, e.g. the Nordic Mobile Telephone (NMT), and the fixed communications systems was such that a special approach was required (Mouly & Pautet 1992, 73). The European Telecommunications Standards Institute, ETSI, dedicated a full series of GSM technical specifications, the 12 series, for network management. The GSM specifications adapted the TMN principles (European Telecommunication Standard 12.00, 1996, 21) and a new system, the Operations and Maintenance Centre, OMC, had been born (GSM 12.01, 1996, 16).

During the development of GSM, the focus was shifted from only operations and maintenance to the overall management of the network. The systems were adapted and renamed from OMC to Network Management Systems (NMS). Today, the focus is on comprehensive support for the operations of the CSP, and the central piece of equipment bears the name OSS (Operations Support System).

3.4 State of OSS Industry

3.4.1 Industry Structure

This chapter examines the structure of the OSS industry and proves with a few examples that the industry lacks a clear, commonly agreed architecture. In the end, one model is selected to be used as basis for the study.

Let’s start by comparing the reports of two widely recognized OSS analysts. Heavy Reading, a New York based enterprise research company split the OSS industry into the following 13 categories in their OSS Market Perception Study (2005, 7).

- Billing*
- Mediation*
- Revenue Assurance & Fraud management
- Middleware
- Customer Relationship Management*
- Multivendor Element Management Systems
- Resource & Inventory Management
- Fault Management
- Performance Monitoring*
- Service Management*
- Test & Measurement
- Service Activation
- Service Provisioning

OSS Observer, an Illinois based, strongly OSS focused market research company has partitioned the OSS market into 19 segments, most of which can be seen as sub-segments of the four main segments (Figure 5) (Detailed Global OSS Forecast of 19 Segments, 2005, 3).

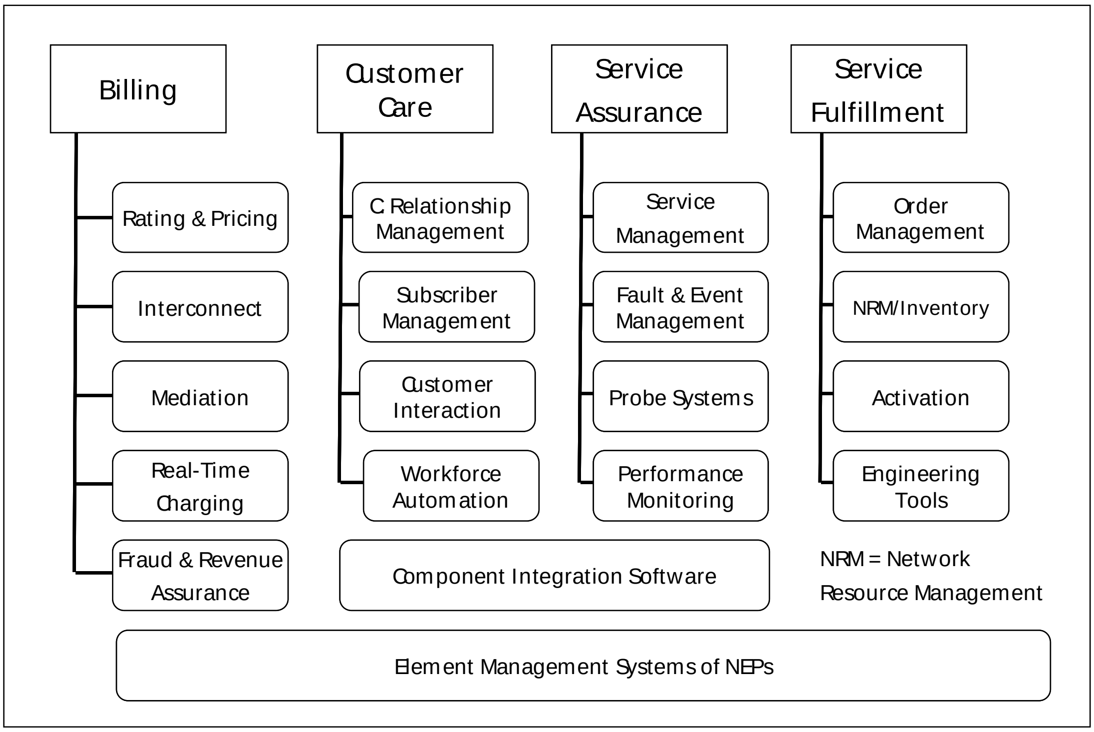

Figure 5 OSS Market Segments According to OSS Observer

Five of Heavy Reading's categories (asterisk "*" in the list) match directly to the OSS Observer's segments. Although the former treats mediation as a sub-segment of billing and the latter sees them as parallel segments. Looking at the similarities, it is possible to match five more (below).

Heavy Reading	**OSS Observer**
Revenue Assurance & Fraud Management	Fraud & Revenue Assurance
Fault Management	Fault & Event Management
Test & Measurement	Probe Systems
Resource & Inventory Management	NRM / Inventory
Service Activation	Activation

For element management, Heavy Reading has a Multivendor Element Management Systems category whereas OSS Observer is talking about NEPs' Element Management Systems, i.e. there is a multivendor and a proprietary approach.

If we would ask these two analysts to describe their categories and segments, it is likely that they would allocate at least somewhat different process tasks even to the containers holding exactly the same name. The most significant difference is naturally formed by the 2 categories and 9 sub-segments that the other author has not included at all.

The result is not arbitrary, but in the OSS industry each participant tends to push its own definition for the industry borders and inner architecture (for example: Operations Support Systems 2005-2010, 2005; Terplan, Kornel 2001).

TeleManagement Forum (TM Forum), the leading and globally recognized OSS industry organization with over 500 member companies (Our Members [homepage on the Internet] c2006. Available from: http://www.tmforum.org/browse.aspx?catid=737), has published the Enhanced Telecom Operations Map (eTOM). The development of TOM started in1995 and the eTOM Framework release 5.0 published in 2005, has been approved by ITU-T as an international standard (Enhanced Telecom Operations Map 2005, 1; ITU-T Recommendation M.3050.0, 2004, i).

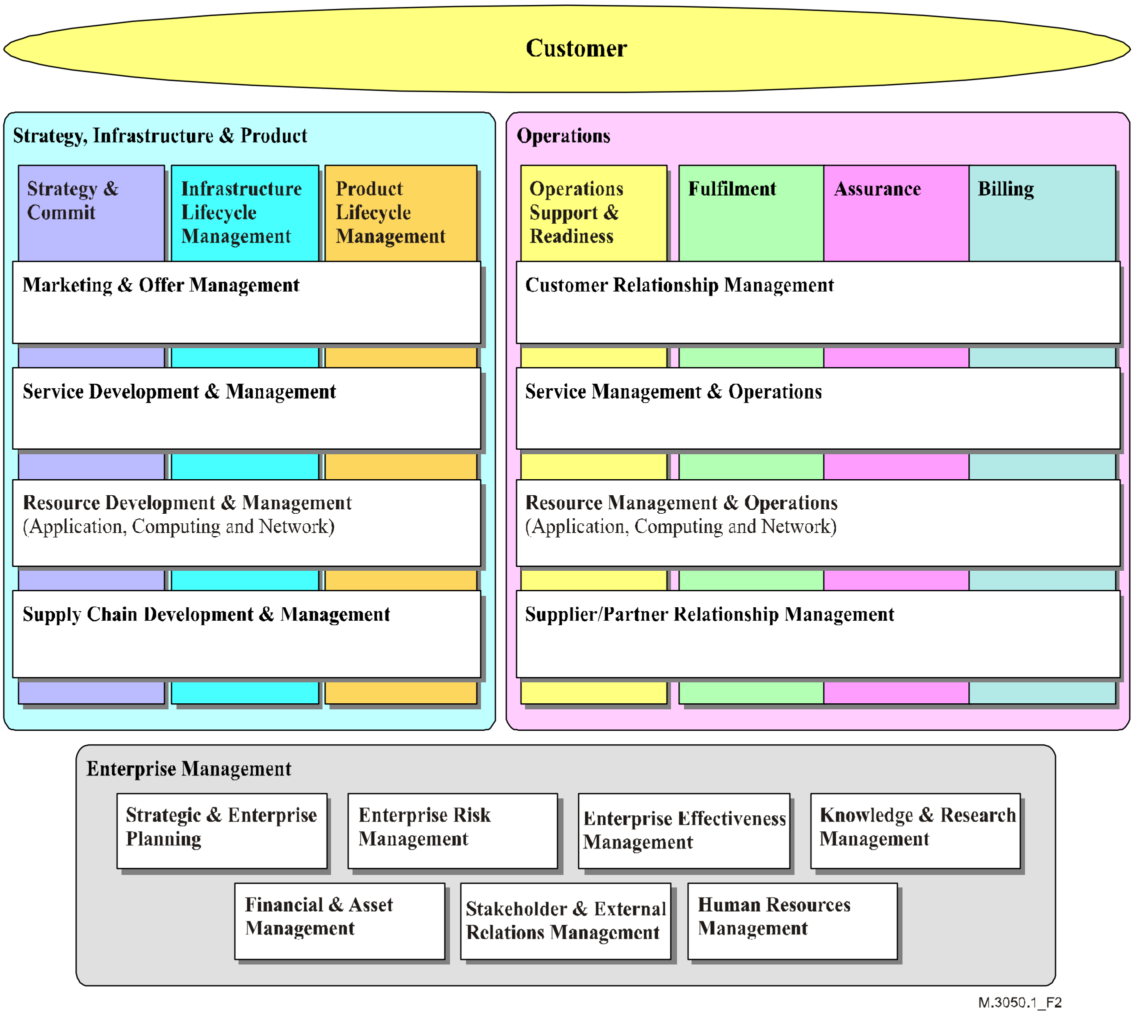

Figure 6 eTOM Level 1 Processes (ITU-T Recommendation M.3050.1, 2004, 12)

The eTOM Framework describes the business activities of a CSP (ITU-T Recommendation M.3050.0, 2004, i). It is composed of four levels each of which describes the processes of the previous level more in detail. The big picture, i.e. level 1 processes are presented above (Figure 6) and the decomposition of Service Management and Operations to level 2 processes below (Figure 7).

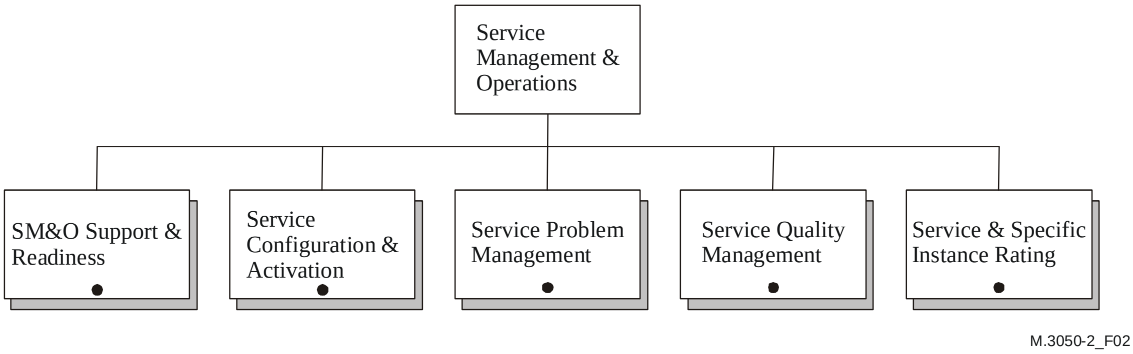

Figure 7 Service Management and Operations Level 2 Processes (ITU-T Recommendation M.3050.2, 2004, 54)

The eTOM framework is a tool for CSPs to ensure that all important processes have been properly covered and level 4 is already very detailed. However, because eTOM is only a framework, it is not possible to be eTOM compliant and it does not provide an efficient cure for the incompatibility problem (eTOM Hands-on Clinic 2004).

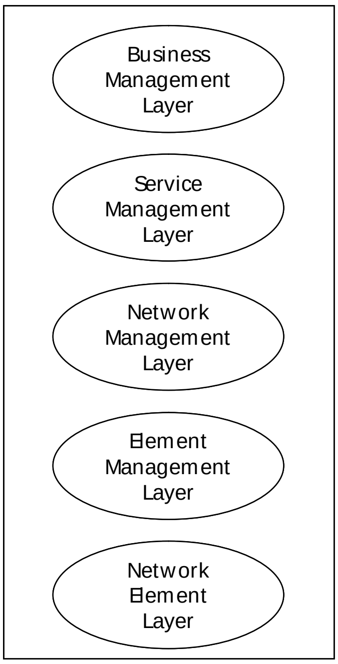

Figure 8 Layered Model of ITU-T for Management Functions

ITU-T has proposed a widely referred layered model for the TMN management functions (Figure 8) (ITU-T Recommendation M.3010, 2000, 16). It is often drawn in the form of a pyramid to reflect that an upper layer is based on the information and services provided by the lower layer. There cannot be network management without capabilities first to manage individual network elements. The recommendation permits additional or alternative layers and the interaction of non-adjacent layers, which significantly weakens the model (ITU-T Recommendation M.3010, 2000, 17).

In this study, the three middle layers of the ITU-T model are used to give structure for the OSS industry. The model is simple, but describes well the relationship between the layers. The network elements are excluded as part of the infrastructure and the business management has been excluded from the scope (Section 1.4.2).

3.4.2 Participant Types

As the industry is missing a clear, established structure and has a wide number of participants, categorizing the industry members to any structure is not self-evident. However, the following structure works in the sense that most of the companies [tested with one hundred TM Forum member companies (Our Members [homepage on the Internet] c2006. Available from: http://www.tmforum.org/browse.aspx?catid=737)] can be categorized, the types are meaningfully different and the multitude of business relations in the industry can be explained with the model. To finally ensure the validity, the model is verified in the empirical phase (Appendix 3, question 5g; Section 5.7).

Communication Service Providers (CSP) are the OSS industry clients like Vodafone, NTT, Orange, CMCC and Telia-Sonera. The main business of these companies is to provide communications services to consumers and enterprises and they need an OSS system to operate their networks. For them, the OSS is a capital good and their OSS strategies vary from partial own development and integration to full purchasing.

In order to reflect and investigate the impact of the size and reach of the CSPs, they are further divided into three subtypes: Global CSPs, the Regional Mega CSPs and the Independent National CSPs (Section 3.1).

Network Equipment Providers (NEP) are companies like Ericsson, Nokia and Huawei whose main business at least from the revenues point of view is to develop, sell and install communications equipment. Recently, they have started also to operate as service communication networks. In order to be able to provide turn key deliveries, these companies must have an OSS solution in their portfolio. The strategic importance of

OSS as profit generator for these companies varies significantly (NEMs Operational Management Systems 2005, 3).

Major Software Companies (MSW) like HP (Hewlett-Packard) and IBM are enterprises whose main strength is the ability to develop and manage substantial software systems. With increasing significance of software in the communications equipment and with the increasing economical value of the management of the communications networks, the OSS market has started to be interest to these giants. Typical for companies in this category are their strong software capabilities and that the OSS represents only a fraction of the revenues.

Independent OSS Vendors (IOV) like Agilent and NetCracker are companies who typically provide focused niche solutions, for example for service provisioning and activation, network analysis or radio network optimization. For these companies harmonization would probably increase the available market, but also force them to compete much more directly against each other, NEPs, MSWs and possible entrants. Because each niche requires somewhat different skill set and approach, it is difficult for these companies to grow by succeeding in several niches.

Software Subcontractors (SWS), like Wipro, Aricent (former Flextronics Software Systems) and Sasken, are companies whose main business is to develop software as a service according to the specifications of their clients. Today these companies are still in the service mode, but could basically enter the OSS market with their wide know-how gathered during the past fifteen years by serving several NEPs, IOVs, CSPs and MSWs. The SWSs have recently started also to develop their own products and accumulate their own IPR (Aricent delivers innovative software [homepage on the Internet] c2007. Available from: http://www.aricent.com/products/equipment-manufacturers-products.html). The temptation for them would be to earn higher profits by selling the same IPR protected software several times and the drawback would be the unavoidable conflict with their current clients.

Systems Integrators (SI) like Jasmine, Integratis and RGV are companies whose main business is to integrate and get the network to work or extend a communication network composed from subsystems of different vendors. These are the companies whose remarkable revenues are based on the high integration effort of the OSS systems.

CSPs' Internal *OSS Development Departments* are not included in this study as separate participants as they are fading away and do not act anymore visibly in the industry. However, if existing, they are treated as part of the CSP.

IT System Vendors (ITV) like HP, IBM, Sun and Dell are the enterprises on whose computing platforms the OSS systems are running. During the development of the OSS industry, there has been a shift from proprietary, telecom or OSS specific hardware to general purpose, commercial server hardware. This has enabled the OSS companies to use a thickening layer of general purpose software including the operating system, database system and protocol stacks. An important question for the ITVs is would their deliveries increase sufficiently to cover the costs and risk, if they would start offering OSS specific hardware solutions? The same question is related to the option of drastically increasing the OSS specific software content that is available with the hardware.

Standardization Bodies, Analysts and other OSS Industry Organizations (IO) like the TM Forum. These non-profit organizations work as sponsored by the members on a voluntary basis. They drive standardization and other important initiates, but lack the capability to forcefully steer the industry.

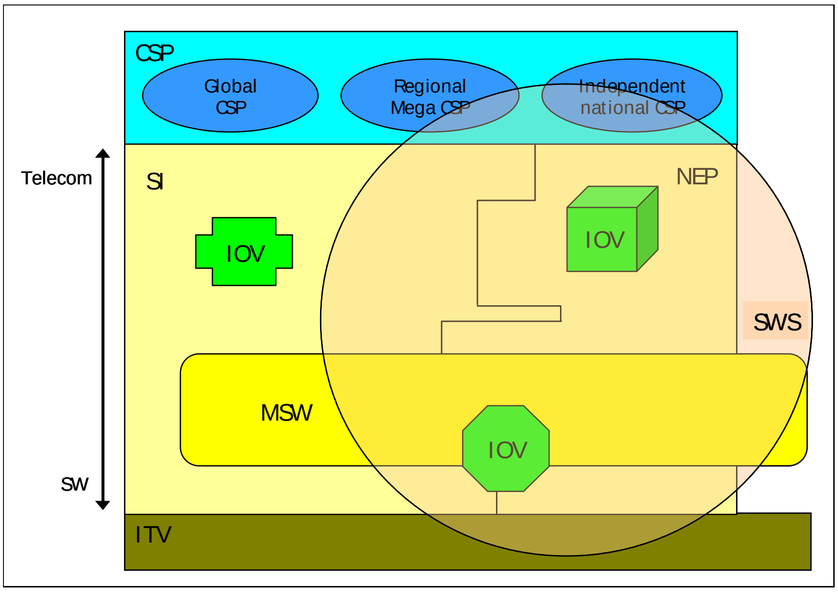

Figure 9 OSS Industry Participant Types

The complex relationship between the OSS industry participants is depicted in the Figure 9. The OSS needs of the CSPs are served by the NEPs, who might use IOVs, MSWs, SWSs and SIs to create their offering. The CSPs get system deliveries also from SIs, who again may use all the other vendors as sub-system providers. CSPs also subcontract projects directly to the SWSs. IOVs provide efficient niche solutions. All the systems are running on ITVs' computing platforms. The OSS represents only one of their business segments for the MSWs, SWSs and ITVs.

3.4.3 Leadership

According to Heavy Reading, Inc. the OSS industry lacks a leader. In their study of 13 categories (Section 3.4.1), MicroMuse was recognized as the leader in two categories, in all the other categories the leader is a different company. Also, the runner-ups varied significantly between the categories (OSS Market Perception Study 2005, 8-14).

Gawer and Cusumano (2002, 6) use the term *platform leader* for a company that sets the direction in the industry and enables a group of companies to co-operate by improving a system through complementary innovations. The improved competitiveness of the system is beneficial for each and there is a strong incentive to co-operate.

For example, the Intel Architecture Lab was set up to foster long term external innovation. Intel provided leadership for the industry by driving the architectural progress and stimulating and facilitating innovation on complementary products. This expanded the overall market for the PCs and increased Intel's microprocessor sales (Gawer & Cusumano 2002, 23-25 and 64).

From the industry point of view, the most essential metric for the leader is not its market share, but the ability to set the direction for the industry and pull the companies to co-operate. In order to achieve this, the company has to be trusted by almost everybody in the industry (Gawer & Cusumano 2002, 23-25 and 77).

Missing Leadership in the OSS industry is likely to restrict innovation on the industry level and is thus a candidate for a stabilizing force.

3.5 Regulation of OSS Industry

The communications industry in general is strictly regulated including the very specific standardization of the technology [for example ETSI standard series GSM 01.xx – GSM 12.xx, start with European Telecommunication Standard 01.02 (1993, 7)], allocation of the frequency bands and country specific licensing of the services.

For OSS, the approach has been different since the beginning. In order not to limit the operators or manufacturers, only a logically structured framework is presented for GSM operations and maintenance (GSM 12.00, 1997, 15). The actual defined structure for the operation and maintenance domain is very short, defining an overall hierarchy and numbering rules for the identifiers (GSM 12.30, 1995, 7-9).

In general, the communication standards describe infrastructure as functional entities and their logical interconnections (GSM 12.01, 1993, 17 and 24), i.e. how the network elements look from outside. This purposeful omitting of the internal implementation makes the detailed specification of the implementation dependent operations and maintenance functions very difficult.

An important *dilemma related to the timing of the OSS standardization* is based on the competitive situation between the NEPs and CSPs. When new technologies are in their early development phases, the information related to them is confidential. Discussing in detail the management of a new technology would inevitably reveal it. Therefore, starting standardization appropriately 1-2 years before the introduction of the novelties is in practice rare.

When the new technology is ready for piloting and for the first commercial launches, there is always huge time pressure to fix the management related issues. A remarkable investment budget has been used and the competitors are running to introduce their innovations. The consumer and public expectations are high. In this phase, there is no room for slow standardization cycles where competing companies try to agree technical details on voluntary basis.

When the new communication technology is in use, it is also difficult to impact the management of it. The systems are already working, so why touch them? Major changes to the management approach would likely require changes also to the traffic bearing equipment itself posing a risk for the already established service. In addition, there are new technologies in the previously described phases requiring all the attention they possibly can get. In short, it is too early for standard management until it is far too late.

In general, a strong regulative grip is one factor that can force an industry to reshape itself and cause disruption. As no tightening in the regulative approach towards OSS is foreseen, the *Weak Regulation* and Standardization is a candidate for a stabilizing force.

3.6 OSS Industry Outlook

3.6.1 OSS Industry Size and Revenue Distribution

According to Gartner (Operations Support Systems 2000-2010, 2006, Sheet Worldwide), the external OSS industry exceeded 15 billion euros annual revenue in 2005, out of which the systems integration services represented 75% (Figure 10) The cumulative annual growth during 2006-2010 is estimated to be 8.7% for the integration area and 5.4% for the software area which will grow the integration portion to 78% by

2010. Surprisingly, each euro spent on OSS software, will generate almost four euros for the integration work.

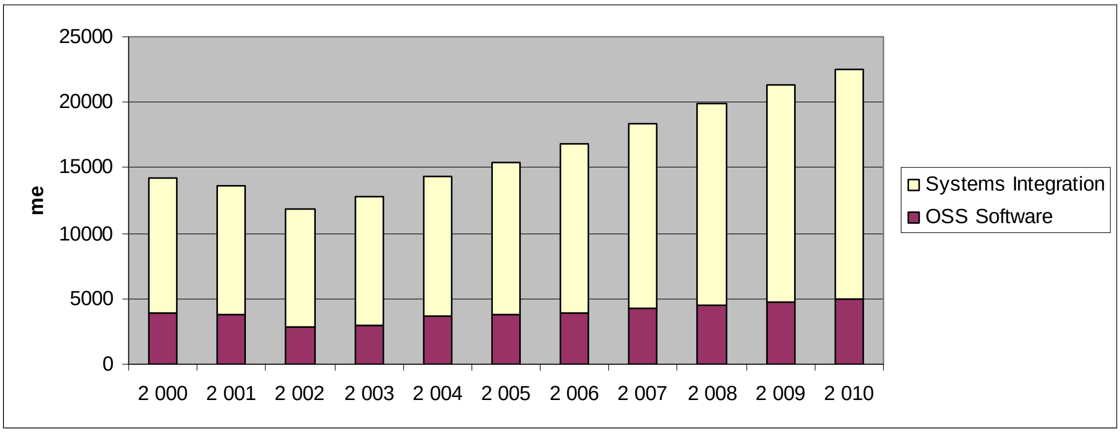

Figure 10 Global OSS Market and Forecast by Gartner

Due to the economies of scale of software development, it is rational to expect that the internal work of the CSPs is even more integration oriented than the balance on the commercial market.

Over the lifetime of enterprise software products, 70% of the total customer costs may easily be formed by the service and maintenance fees (Cusumano 2004, 28). Based on this figure, the 75% proportionate *Integration Cost* of OSS systems is very high as it excludes the other services and maintenance and therefore is a candidate for a disruptive force. Typically, separate companies provide the system integration and the OSS products, i.e. smaller integration expenses would increase the market potential for the product companies, a phenomenon which strengthens this force.

3.6.2 OSS as Part of Telecom Infrastructure

Gartner estimated the overall OSS revenue to be 16.9 billion euros in 2006 (Operations Support Systems 2000-2010, 2006, Sheet Worldwide). When this is divided by their estimate of 99.0 billion euros for the corresponding total telecom infrastructure revenue (Global Telecommunications Market Take 2006a, 5), we get an estimate of 17% for the relative value of OSS. However, in these figures the “integrally related services”, i.e. the integration work is included in the figures.

It is difficult to obtain industry estimates about the value of the OSS software without services and the overall value of telecom infrastructure without services in order to compare the value of purely management software and managed equipment. However, in order to get a rough idea, it is possible to investigate the leading NEP, Ericsson.

OSS Observer estimated that in 2004, Ericsson achieved about 9% of its turnover from OSS (NEMs Operational Management Systems 2005, 3) which is about 10% of its system sales. In 2005, services represented 28% of Ericsson's system sales (Ericsson Annual Report 2005, 16) which again makes the 75% integration cost on the OSS market appear high (Section 3.6.1).

Ericsson did not indicate how the division of sales between radio and core network equipment was done. A fair assumption is that the sales of the radio equipment installed in volumes to cover land masses is higher, than the sales of the switches and servers used to connect users and produce services. A suggestive ratio of 60-40 is very rough estimate, but probably safe and accurate enough. Combining these figures and assuming a similar proportional OSS income for 2004 and 2005 it is possible to draw a sketch for Ericsson's infrastructure sales (Figure 11).

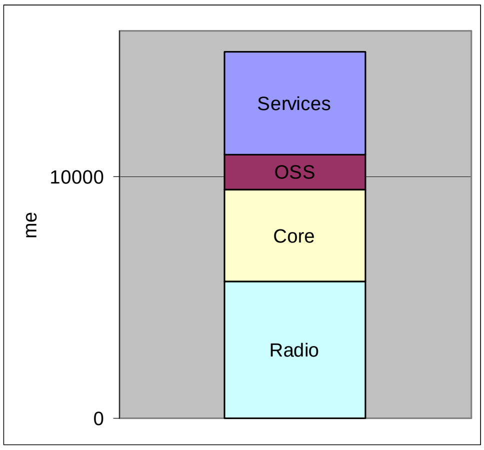

Figure 11 Estimate of OSS as Part of Ericsson's System Revenues 2005

With this figure, we can discuss reasons that according to Porter (1998, 115-116) make the buyer, i.e. CSP not sensitive to the price of OSS. First, the cost of the OSS compared to the total cost of the infrastructure is small. Nagle and Holden (2002, 93-94) have given this price perception diminishing phenomenon the name *total expenditure effect*. In this study, the OSS *Cost as Part of Infrastructure* is a candidate for a stabilizing force.

Secondly, the consequence of an OSS failure is high relative to its costs. Possible OSS problems might collapse the value of the infrastructure, similar to how a missing steering mechanism would collapse the value of a car. *High Failure Penalty* makes CSPs sensitive for radical OSS changes and is a candidate for a stabilizing force.

Thirdly, effectiveness of the product can yield major savings. For example, proper optimization of the radio network with suitable OSS software can improve the coverage tens of percents, i.e. requiring significantly less costly radio equipment, which is usually demanding to install and expensive to maintain. Similarly, OSS software can be used to forecast the required core network capacity in order to match deliveries exactly to the market need and use the capital expenditure budget efficiently. This phenomenon Nagle and Holden (2002, 94-97) introduce with the name *end-benefit effect*.

The low price sensitivity of the buyers means that OSS is an industry where there is an opportunity of high profits. There is also another reason for this. When a communications infrastructure system deal has been signed and the system is in operation, the NEP has close to monopoly position regarding changes and upgrades required to the proprietary OSS system. The maximum price for these services is limited only by the CSP's related total replacement costs (Shapiro & Varian 1999, 116).

In summary, for the NEPs who use OSS as a vehicle to generate above average cross margin sales, it might be beneficial to maintain the scattered status quo on the market and *NEP Profits* is therefore, a candidate for a stabilizing force.

Interestingly, there are a few NEPs that have abandoned this approach. For example, Ciena and Juniper were estimated to earn less than 1% of their revenues from OSS in 2004 (NEMs Operational Management Systems 2005, 3). The likely reason for this kind of an approach is a situation where the OSS functionalities are provided by a partner company. Another alternative is an approach to give OSS functionalities for free in order to win system deals, but this kind of behavior naturally has its drawbacks as the costs have to be then covered by the other elements, and the possibility for benefiting from after deal sales and profits is seriously impacted.

As summary, the following candidates for stabilizing forces are related to the role of OSS as part of the infrastructure: *Cost as Part of Infrastructure, High Failure Penalty,* and *NEP Profits.*

3.6.3 OSS Value Chain

Based on the selected three layer structure for the industry (Section 3.4.1) it is possible to sketch a value chain for the industry (Figure 12).

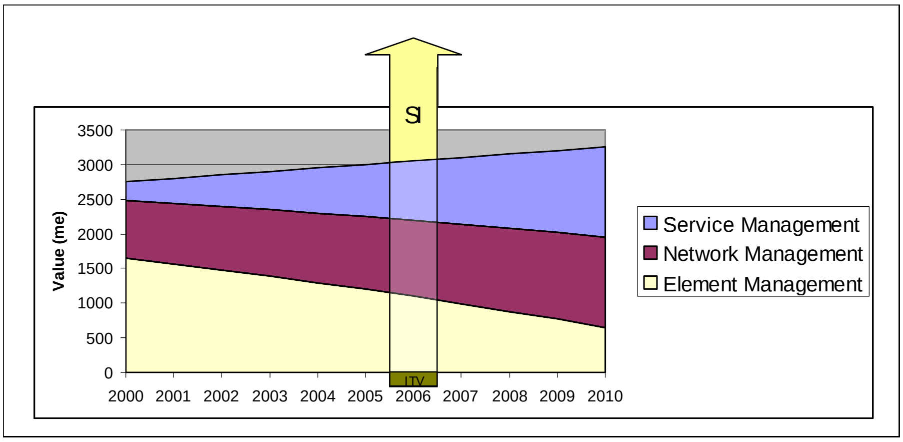

Figure 12 Approximate OSS Value Chain

The new services which are important from the revenue, profitability and competition point of view require a growing share of the management. The network management share cannot be squeezed much due to the inflow of new technologies, releases and the need to manage bigger systems as one. As part of a maturing industry (Section 3.2), the overall size of the OSS industry revenue is substantially rigid which leads to strong pressure to find savings in the development and price of the element management functionality. This is intensified by the price erosion of the hardware-oriented network elements.

3.6.4 Outsourcing of Network Management

According to the research of Magnus Innala and Anders Bråténius (2005, 13), almost half of the largest global mobile CSPs either have or are considering to outsource network management which is significantly more than in 2003. The main reasons to outsource are financial, whereas the risk of losing control was regarded as the main hindrance of the development. Other possible reasons to outsource, are the need to focus key technical people on new technologies (e.g. outsource GSM, focus on 3G), reduce time-to-market and to manage the risk related to rapid personnel growth (The New Frontier for Vendors 2006, 32-33).

The magnitude and the financial risk related to the outsourcing contracts are so high that they cannot be hidden, but will have a direct impact on the results of the NEPs. For example, Elizabeth Bramson-Boudreau of Pyramid Research estimated the value of the contract between 3 and Ericsson in the United Kingdom was over 2 billion euros (Ericsson and 3G Operator 3's Deal Only a Precursor [homepage on the Internet] 2005. Available from: http://www.3g.co.uk/PR/Dec2005/2335.htm). Based on this and Ericsson's 21.8% operating margin (Ericsson Annual Report 2005, 1), its proposal to cut the CSP's cost by up to 20% (Innala & Bråténius 2005, 5) must be regarded as very aggressive. How would one operate the networks of experienced CSPs at 20% lower costs and still generate a 20% operating margin?

There are three possible ways to make the outsourcing deals profitable for the NEPs. The first is to operate several networks on the same geographical area with the same team and OSS systems. The second is to strongly streamline the processes and systems. The third possibility is to justify the outsourcing by the strengthened CSP lock-in. Based on the size of the deals, the last one is not enough alone. Therefore, *Network Management Outsourcing* is a candidate for a disruptive force and will create a strong pressure to streamline the processes and OSS system. In addition, the number of the OSS customers in the industry will decrease, if the development continues, which will also, in turn, create harmonization and cost pressure.

3.7 OSS Change Forces

The phenomena, that is described in Chapters 2 and 3, form candidates for disruptive and stabilizing forces in the OSS industry that are summarized in the Figure 13.

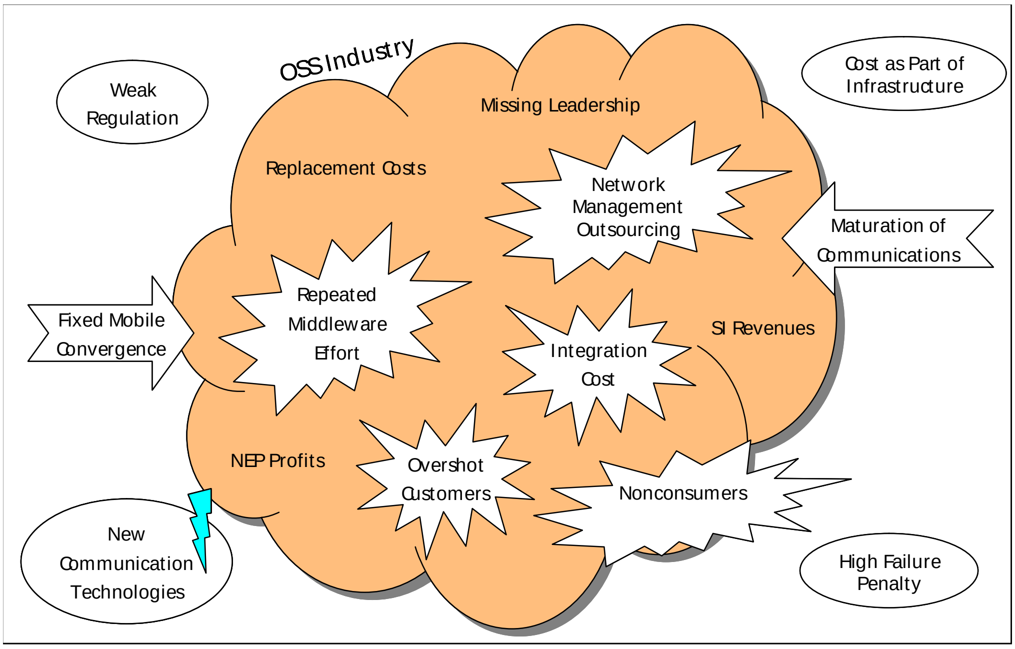

Figure 13 Theoretical Model of Disruptive and Stabilizing Forces

The disruptive forces are divided into two categories based on whether they have a *direct* impact to a specific area of the industry or mainly generate overall, *indirect* pressure to change. The stabilizing forces are categorized based on whether they are industry's internal or impact it outside as external forces preventing or slowing down change. Finally, there is one force that has both disruptive and stabilizing elements and is categorized as bidirectional.

3.7.1 Direct Disruptive Forces

(These are shown visually as explosions in the figure Figure 13.)

Overshot Customers are CSPs, for whom a more straightforward and lower cost OSS system would be sufficient or even more desirable. Most likely these customers can be found in the group of Independent National CSPs who do not have as many suppliers and who do not operate in as multiple locations as the other CSP sub-types (Sections 2.1 and 3.1).

As the integration work does not add any direct benefit and could be significantly reduced by a more compliant industry architecture and approach, the natural question is how long the CSPs, NEPs and IOVs are going to tolerate the OSS system *Integration Cost* that is approaching 400% on top of the value of the systems itself (Section 3.6.1). This is a direct force pushing the industry towards a more precisely defined architecture and intensified OSS vendor co-operation for the compatibility.

Currently each NEP develops independently the basic OSS specific software layer that is mandatory, but does not yet provide differentiation. With a suitable approach, the approximate ten NEPs could share developed software that has been developed once and save effort and cost for differentiating and more value-adding development. Also very likely, the integration of the different OSS systems would be easier, if they would be based on the same middleware software layer. *Repeated Middleware Effort* is a direct force pushing the NEPs to either share their middleware software or to purchase it from a common third-party source (Section 2.5.5).

Nonconsumers are companies or departments that do not currently use OSS systems for specific purposes, but could use them, if they would be slightly modified or if the price would drop to a justifiable level (Section 2.1).

Network Management Outsourcing leads to a situation where a single company operates multiple networks. In order to operate the networks more cost efficiently, than the experienced CSP who has outsourced the operations, the company must streamline the operating processes, automate tasks and deepen the skills of the personnel. All this would be easier if all the OSS systems would be more similar. Outsourcing leads thus to pressure to either harmonize OSS systems or even to replace them with the company’s standard systems (Section 3.6.4).

3.7.2 Indirect Disrupting Forces

(These are shown visually as arrows in the figure Figure 13.)

The communications infrastructure industry is moving towards maturity in its life cycle which means that competition is fierce and all possible extra costs are cut (Section 3.2).

The increased cost pressure is not addressed specifically, but *Maturation of Communications* impacts OSS as a general driver for change to achieve savings.

Fixed Mobile Convergence is the next foreseen major restructuring of the communications infrastructure (Section 3.1.4). As the fixed, mobile and broadband communication infrastructure will merge, there is natural pressure to unify also the management approach and systems. For the OSS industry, this means general pressure to harmonize without yet actually knowing a way to do it in practice.

3.7.3 Internal Stabilizing Forces

(These are shown visually as text within the clouds in the figure Figure 13.)

The opportunity for *NEP Profits*, which are provided by the fragmentation based lock-in after an infrastructure system deal is won, is a stabilizing force (Section 3.6.2). As the profits are generated within the OSS industry, this is classified as an internal force.

With the current scattered OSS industry structure, the *SI Revenues* are high (Section 3.6.1) which naturally makes SI companies strong supporters of the status quo. As integration work is part of the OSS industry, this is an internal force.

If there is a change in the OSS systems, they have to modified, upgraded or changed which leads to many direct and indirect *Replacement Costs* that can even exceed the direct price of the OSS system itself (Section 2.6). This naturally slows down any changes. As the major part of the replacement costs can be assumed to occur within the OSS industry and from direct related costs like training, and not from the modifications of the interfaced systems, the switching costs are classified as an internal stabilizing force.

Structural industry change is much faster, if there is a recognized leader like Intel has been for the architecture of the PC industry. *Missing Leadership* in the OSS industry either slows down or prevents a radical structural change (Section 3.4.3).

3.7.4 External Stabilizing Forces

(These are shown visually as ellipses in the figure Figure 13.)

Weak Regulation does not help reshaping and is likely to support the continuation of the dominant shattered industry structure (Section 3.5). As a strong regulative force is more likely to be an OSS industry external force, for example a government or a higher level standardization body like ETSI, weak regulation is classified as an external stabilizing force.

High Failure Penalty is related to the fact that if there is a fatal problem in the OSS system, the much more valuable communications network will experience serious problems. This naturally makes the CSPs sensitive for radical OSS changes (Section 3.6.2). As the reason for the sensitivity is the value of the parent system, from the OSS point of view, the high failure penalty is categorized as an external stabilizing force.

Cost as Part of Infrastructure refers to the relatively low, below 10%, portion of OSS that comes from the overall pure communications infrastructure costs, that according to the Porter's theory, makes the buyers likely to pay attention to the higher cost items and thus reduces the change pressure on OSS (Section 3.6.2). Similar to the high failure penalty above, this is classified as an external force.

3.7.5 Bidirectional Force

(This is shown visually as an ellipse with a thunderbolt in the figure Figure 13.)

New Communication Technologies both open a natural renewal window for the support systems, but also pull energy from major OSS improvements to the introduction of new services (Section 3.5). Therefore, this is both an indirect disruptive and external stabilizing force. This force is different to *Fixed Mobile Convergence,* in that its focused scope is to introduce new technologies to parts of the systems, while *Fixed Mobile Convergence* might replace the entire production machine.

4 EMPIRICAL STUDY

This chapter describes the empirical phase of the study. How the interviewees were selected, how the data was collected, processed and analyzed, and what makes the results of the study reliable and valid. The scales that were used to quantify the probabilities and strengths are presented in the Section 4.3 (page 53).

From this point on, all the references to the interviewees Ralf Vorbrig (Vodafone), Dmitry Polpoudenko (MegaFon), Markku Pesonen (Elisa), Alfred Schmidbauer (Siemens), Guy D’Hauwers (HP), Kevin Koenig (ex-Sasken, ex-Lucent), Randy Custeau (Agilent), Kari Pasonen (Comptel) and Keith Willetts (TM Forum) refer to their interview for this study, during November and December 2006, as specified in the Chapter 7 References, if not otherwise indicated.

4.1 The Focus Group of the Study

The selection concerning the interview objects was based on the assumption that the first representative of each industry participant type adds the most value and even one carefully selected representative for each type is enough to evaluate the developed theoretical disruption model. Additional participants would probably fine tune the sensitivity of the results, but one representative is enough to cover the most significant views.

The risk of omitting something important due to the limited number of interview objects is reduced by two measures. First, in order to succeed in their work the interviewees have to think also from the point of view of their counterparts. Many have even been working for several types of OSS industry participants during their careers. Secondly, a non-profit OSS industry organization representative with very large network was interviewed in order to get another view for the represented participant types, in addition to having a neutral, overall view.

The TM Forum Board Member, Jaakko Aho (2006b), was interviewed in order to verify the feasibility of the developed industry structure model (Section 3.4) and to list companies that would well represent the targeted interview objects. After this, the personal network of the investigator was used to identify a suitable interviewee candidate within each interview.

Special attention was paid to identify interview candidates who have long industry experience and that are appreciated for their wide views and future-oriented thinking even outside of their own organizations. The process to identify and engage the interviewees through their personal acquaintances worked well and shall be assumed not to have biased the results to any specific direction. The process is described more in detail in Appendix 2.

The investigator joined Nokia for the first time in 1989 and has worked in OSS or the telecommunications systems related positions since 1992. In order to avoid bias, Nokia was not included to this study as a study object. In addition, the study has been entirely conducted during an unpaid study leave.

4.2 Data Collection and Variables

The decision not to record on tape the interviews was done based on the strict recommendation of Juho Seppälä (2006). He has extensive global experience on inter-company relationships covering all of the represented cultures and his view was that recording could easily create an atmosphere where sensitive matters will be omitted. The interviews were about future-oriented strategic issues that are by nature sensitive and, therefore, only manual notes were done during the interviews.

In order to improve the quality of the collected material the most important findings were recorded separately and the interview notes verified and extended within one day after each interview.

If an interviewee did not have an opinion, he was not pressed for it, but instead the question was left unanswered. Permission was asked and received from each interviewee to contact him afterwards in order to further clarify issues related this study, if required.

The interview questionnaire (Appendix 3) was composed of the following parts.

1. Introductions
2. Motivation: purpose of the research
3. Definition of the key concepts
4. Structure of the interview (explained)
5. General questions
6. Theory-based questions
7. Probability and strength estimation for each force
8. Closure

The investigator was leading the discussion through the first four parts and the eighth part of the questionnaire. During the substance of the interview, which is the fifth and sixth part, the interview followed the thinking of the interviewee. In practice, the investigator started with the first question (5a) after which the interviewee was allowed to freely elaborate on the issue until that theme was exhausted. After this, the interviewer continued with the next unanswered question.

The approach ensured two important goals. First, the interviewees' thinking about the forces were recorded (fifth part) before he was exposed to the ideas related to the theoretical model (sixth part). Secondly, in the general part the approach was to ask first, what is happening in communications in general, and only after that discuss what it might mean for OSS. If the interviewee had an area of special interest or expertise, more time was spent with it.

The questionnaire was reviewed prior to the interviews by Professor Hannu Kuusela and Kari Loukola. During the first interview (Pesonen), it was noted that *Network Management Outsourcing* related questions (6x and 6y) were missing from the questionnaire. The matter was anyhow covered during the interview as it was also included to the template for probability and strength estimation (Appendix 3, Figure 23). These questions were added to the questionnaire after the interview and all the other interviews were then conducted with exactly the same questionnaire.

It should be noted, that Chairman Willetts was preparing himself for his key note speech in the TeleManagement World event in Dallas (Managing the Blue Ocean of Convergence licenses [homepage on the Internet] c2006. Available from: http://www.tmforum.org/browse.aspx?catID=4010) one week after the interview and with him the interview approach was different. He was elaborating the state of the industry and playing with the different future scenarios and for most of the time the investigator was only making notes. Only a few questions were posed in order to pay attention to some of the areas that had not been covered. With the other interviewees the structure followed more the questionnaire format, although several questions were covered without a pause and the exact order of the questions was different with each interviewee.

In addition to the verbal descriptions, two variables were collected for each force: *the probability of the impact of the force to the OSS industry* and its *strength in the case of impact*. The following categories were used to quantify the probability.

0	Not Possible	probability 0%
1	Low	probability 1-33%
2	Medium	probability 34-66%
3	High	probability 67-99%
4	Definite	probability 100%

During the interviews the disruptive and stabilizing forces were treated as separate, but with similar strength scales. For processing purposes their strengths are combined to one scale as follows.

3	Major disruptive force	It will alone change the industry structure.
2	Medium disruptive force	It has impact and can with other forces change the industry structure.
1	Minor disruptive force	It has impact, but will not change the industry structure.
0	No strength	It does not have impact on the industry structure.
-1	Minor stabilizing force	It has impact, but will not maintain the industry structure.
-2	Medium stabilizing force	It has impact and can with other forces maintain the industry structure.
-3	Major stabilizing force	It will alone maintain the industry structure.

These scales are used in all the following probability and strength statistics.

A strength scale with 3 +/- levels worked well in the interviews and was sufficient for the subsequent analysis. A more detailed scale would have required remarkably more attention, probably even a separate second interview.

For probabilities, the upper limit between the scale categories of 3 and 4 could have been 95% instead of 99%. The idea of separating facts and highly probable events was good, but in a rapidly changing industry environment 95% probability, in reality, has to be already considered as a fact in the most decision making situations. Due to this, a few findings, that in practice are facts, are categorized with a high probability. However, this does not impact the overall results of the study, because on a high level these categories are treated similarly.

The existence of a force could be treated as a third, binary variable. In order to avoid this, the results have been interpreted, so that if a force does not have probability or strength, it does not exist.

4.3 Data Processing and Analysis

The seventh part of the interview, the probability and strength estimation for each force, was planned to be and used as a time buffer. This was the part to omit, if the time was running short, in order to protect the leisured and proper coverage of the fifth and sixth parts.

Pesonen, Schmidbauer and D'Hauwers estimated the strengths of the forces by themselves. The investigator estimated the strengths of the forces for the other 6 interviewees based on the interview notes. For the most part, the task was straightforward as the interviewees had been using very descriptive, explanatory language. A few examples:

- Vorbrig: "It is the opposite." as a comment to the proposition of one, single leader making industry more efficient (6n). "No harm." as a comment to the recurring costs related to unused functionality (6b).
- Custeau: "Absolutely.", "Not global. Not significant." as a comment to the regulation (6o).

- Polpoudenko: “eTOM is very good.”, “Used to be.” as a comment to the impact of *Cost as Part of Infrastructure* (6o).
- Pasonen: “Standardization is dead.”, “No.” as the reply to the question do OSS systems contain unnecessary or unused software (6a).
- Koenig: “Incredibly fragmented” as a comment to the OSS industry structure (6g). “Proves my point” as a comment to the integration cost statistics (Figure 10, page 41; question 6e).
- Willetts: “Fundamental change.”, “It is a free fall again” as a comment to the near future development of the communication services.

All the interviewees have a long experience in the usage of precise verbal language. They have been talking to customers, collaborators, management and employees of their own companies for years. On the contrary, the presented quantitative estimation system (Appendix 4, Figure 23 and Figure 24) was new to them although relatively simple. Therefore, in evaluation of the interview findings (Chapter 5) and especially in the few conflict situations more weight is given to the used verbal expressions than to the quantitative estimations.

This approach softens also the possible difference between the findings quantified by the interviewees and the investigator. The quantification was anyhow useful because it prompted the interviewer to think and discuss the forces very explicitly, and steered him to pay special attention to the expressions that were used.

The analysis was done so that essential findings of each interviewee were first collected and recorded to the force specific sections (Chapter 5) and the conclusions for each were drawn only after all the evidence was visible.

4.4 Reliability and Validity of Study

Robert K. Yin has significantly improved the respect for the case study research and is widely recognized as the author of its methodology in psychology, sociology, political science and economics. This chapter investigates the construct validity, internal validity, external validity and reliability of this study according to the book of Yin (2003) that has over 8 000 references (Search: ‘author:"Yin" intitle:"Case Study Research: design and methods"’, Google Scholar Beta [database on the Internet] 2007. Available from:

http://scholar.google.com/scholar%3Fq%3Dauthor:%22Yin%22+intitle:%22Case+Study+Research:+design+and+methods%22+%26hl%3Dfi%26lr%3D%26oi%3Dscholarr).

4.4.1 Construct Validity

The test of construct validity is especially challenging for case study research (Yin 2003, 35). Essential questions are: has a *sufficiently operational set of measures* been developed to study the phenomenon and has *the collection of data been free of subjective judgments*. Yin lists five steps to overcome these challenges.

1. Select the specific types of changes that are being studied.
2. Demonstrate that the selected measures do indeed reflect the specific types of changes.
3. Use multiple sources of evidence.
4. Establish chain of evidence.
5. Have key informants to review the draft study report.

The study has focused on finding disruptive and stabilizing forces that impact the OSS industry during 2007-2010. Industry disruptions do not just happen, but are caused or prevented by something: the forces that we have been looking for.

Whether a force is disruptive or just part of natural development is a question of the speed of change and point of view. For somebody who is penetrating an industry with an innovation, the changes might appear slow, whereas at the same time someone whose powerful empire is collapsing due to the same changes, the speed of change might appear all too fast. Therefore all industrial changes have been treated in this study as disruptions if they are changing things during the 2007-2010 time period, and the impacts are considerable.

Special attention has been paid to identify during the empirical study, also forces that were not identified during the theoretical phase (Section 4.2). The success of this approach is proven by the number of identified new forces and overruled theory based forces (Sections 5.2, 5.3, 5.4 and 5.5).

The theory is based on books, standards, industry reports, electrical references and on the interview with Jaakko Aho (2006a). The newest theories discussed still in the journals have not been included as the target was to adapt the latest, but widely approved and recognized theories to the OSS industry. In the empirical phase, eight persons who cover all the different industry participant types were interviewed in addition to one person with strong overall view (Chapter 7 References).

The chain of evidence is composed as follows. The theory (Chapters 2 and 3) is based on referenced sources. The selection of the interviewees (Section 4.1; Appendix 2) and the interview questions (Section 4.2) are based on the developed theory. All the relevant interview findings related to a force are first listed and the conclusion drawn based on these findings only after that (Chapter 5) (Pentti Järvinen & Annikki Järvinen 2004, 76). The summary and conclusions (Chapter 6) are based on the earlier parts of this report.

Internal references are explicitly used, external references given at the accuracy of page number and hyperlinks included for the electrical references in order to make the possible verification of the chain of evidence easy and convenient.

A draft version of this study report was emailed to each interviewee for possible comments two weeks prior to the freezing of the content. As a result of this, no major changes to the report were implemented.

As a conclusion, the construct of this study shall be treated as valid.

4.4.2 Internal Validity

There are two risks for the internal validity of an explanatory case study. First is the causality of the events. For example, if the investigator concludes that there is a causal relationship between X and Y without knowing that a third factor, Z, has caused Y, the research design has failed to deal with the internal validity. Another risk is that the doing of the research itself impacts the object of the research so that the findings do not anymore represent a real life situation. (Yin 2003, 36)

As the focus of this study has not been on the causal impacts (Y), but on the identification of the factors (X or Z) that cause these impacts, the causality of the findings is not a risk. The interview approach has been to first discuss events on the communications industry level, and only after that, ask what effects they might cause on the OSS industry level. The focus has not been on the cause of impacts, but what is the probable impact of a known cause (Section 4.2).

The OSS industry with 15 billion euros external revenue (Section 3.6.1) is such a giant that the nine interviews that were done can be estimated to have no impact on the industry, especially as the focus of the interviews has been to listen to the interviewees. As the future development is constantly on the agenda on industry gatherings, also the tiny additional attention to these issues due to the publication of the study results cannot be estimated to change the course of the development, only to make it hopefully a bit more clearly visible.

As a conclusion, the design of this study shall be considered as internally valid.

4.4.3 External Validity

The question of external validity is related to the question how widely the results of the study can be generalized (Yin 2003, 37). The focus of this study has been limited to the possible disruptions in the OSS industry during the time period of 2007-2010 (Section 1.4.1). The results cannot be generalized beyond that, although in Section 6.5 a few industries that might be interested in the findings will be listed.

All the interviewees are currently based in Europe or North America. These countries, with the innovative Asian countries, are the regions on the forefront in communications and thus industrial changes are likely to be first visible here. The main reason to consider the geographical representation as sufficient is however, that all the interviewees, except Polpoudenko and Pesonen, work in global organizations. Sasken, the former employer of Koenig, is even based in India.

Naturally, innovations can take place everywhere, but especially in the OSS industry, which is related to the savings of expensive work force, the focus of new development is in the mentioned regions. The risk of replacing existing OSS software with cheap labor in developing countries is reduced by the zero variable cost of software: selling existing functionality at a low price to these countries is still profitable. Moreover, the skills required to manage and optimize communication networks are normally scarce and expensive also in those countries.

As a conclusion, the results of this study can be generalized to the OSS industry and thus the study shall be treated as externally valid.

4.4.4 Reliability

The essential question of reliability is whether another investigator would arrive at the same findings and draw the same conclusions, if one would repeat this study (Yin 2003, 37). When the context of a study is rapidly changing like the communications industry, the results can be in this sense reliable only for a limited time. Therefore, let's focus on the case where this study is repeated preferably in months and in maximum of a year after the original interviews.

If one would select the interview objects from the 550 members of TM Forum (Our Members [homepage on the Internet] c2006. Available from: http://www.tmforum.org/browse.aspx?catid=737) one might interview Vodafone as the leading CSP, but probably other companies as regional and national CSPs. One would have less than 10 NEP candidates, only a few alternatives for HP and Sasken, but a multitude of IOVs. TM Forum, one would naturally select as the only widely recognized non-profit OSS industry organization. This would lead to interview mostly other people. However, as the study objects for this study were selected based on the developed model for the industry structure (Section 3.4) and the interviewees carefully selected and invited based on that (Section 4.1; Appendix 2) they can be assumed to represent the industry well.

The coverage of the industry can be estimated also by looking at the findings. As the answers in general questions correlate well, but represent also the different points of view of the interviewees, they can be assumed to represent the industry well. For example, the interviewees agreed that the industry is missing a leader, but the representatives of big companies, who probably consider themselves as leader candidates, considered this as a problem and the representatives of small companies, who would be probably dictated by the rules of a leader, consider the possible arrival of a strong leader as a problem (Section 5.4.7).

If one would interview someone from the same companies, one would, with high likelihood, end up interviewing exactly the same persons. At least during this study, it was very easy and clear to identify who is the person in a company that should be interviewed (Section 4.1; Appendix 2). Only in one case out of nine there were two alternatives names initially mentioned.

As the OSS industry is missing a recognized structure (3.4), the other investigator would end up interviewing types of companies. However, a slightly different industry model cannot be assumed to significantly change the type of the interviewed companies. The different, alternative models for the OSS industry structure must be on the high level similar, composing of CSPs, NEPs, major multi-industry giants and smaller OSS specific software and integration companies, and a different model of these could even lead the investigator to interview the same companies. An important question is whether an industry player type is missing, which seems not to be the case. At least nothing like this was raised during the interviews although the industry including its structure was discussed widely and deeply.

The naming of the forces has been more or less arbitrary, and probably another investigator would give some of the forces a different name. The forces also correlate, the investigation of which has not been the focus of this study. Therefore, another investigator might represent the same forces with a bit different number of vectors, although their absolute impact can be estimated to be the same.

In order to facilitate the possible repetition of this study, a *case study database* as recommended by Yin (2003, 38), containing all relevant study material including the original interview notes and printed Internet references has been established and is conserved by the investigator.

As a conclusion, from the content point of view, another investigator is expected to draw the same conclusions and thus this study shall be regarded as reliable.

5 ESSENTIAL RESULTS OF THE STUDY

This chapter begins with the future of the whole communications industry as seen by the interviewees. This is followed by the main interview findings for the disruptive, stabilizing and bidirectional force, one by one. The theory (3.7) based forces are covered for each type prior to the new forces identified during the interviews. Finally, there is a short list of forces that could have surfaced during the interviews, but did not; followed by the confirmation for the used industry structure model and a summary concerning the disruption optimism of the interviewees.

Refer to the Chapter 4 (page 50) for the full list of the substance interviewees and their employers, and to the Section 4.3 (page 53) for the used probability and strength scales.

5.1 Future of Communications Industry

Each interview was started with a discussion about the future of communications and OSS without any indications by the interviewer about the possible direction this industry is headed. This chapter summarizes the foreseen visions.

Pasonen described the rapid transition around the year 2000, as a rare consequence of two simultaneous technology transitions: the Internet and the mobile communications. He was uncertain whether anything like that is going to happen in the near future.

Willetts described the overall situation as an interesting concoction of advertisement, retail and communications boiling together without anybody really knowing what is going to come out (Figure 14).

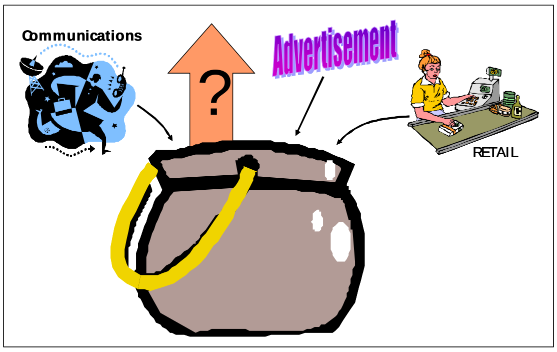

Figure 14 Keith's Pot

He was very confident that we are stepping to a major disruption and after five years the communications and OSS industries will look very different. He estimated communications to become truly global like the oil business today and the consolidation of the CSPs to continue. The global CSPs will start to operate globally and not as a group of national companies, which is often the case even today.

Willetts forecasted that in the future the content of communications will come from content companies like TimeWarner and Google and not from the CSPs. He compared the situation to the traditional telephone calls where the content, voice, is produced by the callers, not by the operator. Actually, Willetts saw a very important role and opportunity for CSPs as providers of competitive service delivery platforms, which include billing, authentication and repurposing of the content for the hundreds of different screen types of mobile devices.

Today DoCoMo´s i-Mode in Japan is a rare success story of mobile content services where the CSP, by really taking a supportive role and with reasonable pricing, has engaged multiple companies to provide content and gained also a very strong end-user acceptance: 45 million users in February 2006 (i-mode History [homepage on the Internet] c2006. Available from: http://www.nttdocomo.com/services/imode/history/index.html; see also i-Mode Frequently Asked Questions [homepage on the Internet] c2004. Available from: http://eurotechnology.com/imode/faq-gen.html).

However, when Willetts has been discussing this scenario with the CEOs of the major CSPs they have been reluctant to accept the role of a utility provider. This resistance might slow down or even prevent the development, but ultimately Willetts was very skeptical whether the current CSPs could convert their enormous organizations to efficiently compete with the quickly emerging and rapidly moving content companies.

D´Hauwers expects the technical architecture of the communications industry to change from a vertically integrated system to a pile of layers, a formation that in the IT industry took about ten years. The layers will have very clear defined interfaces and only the leading vendors will survive on each layer. That would fit also to Willetts' expectation of a clear simplification in the structure of the industry.

Vorbrig estimated possibly a reduction in the number of player types and an upwards transition in the ecosystem. If the CSPs will focus on services and content and leave the operations of the networks to the current NEPs, the newer NEPs with lower employee cost like Huawei might take in turn a stronger position in the equipment business.

Schmidbauer expected also a change towards a more layered architecture by the entrance of the traditional IT vendors, enabled by the improved performance of the general purpose hardware and corresponding diminishing need for the communications specific *carrier grade* equipment and know-how.

5.2 Evaluation of Theory Based Disruptive Forces

This chapter presents the main interview findings and a conclusion for each disruptive force based on the created theoretical framework (Section 3.7).

5.2.1 The Overshot Customers Force

Overshot Customers are related to the low-end disruptions caused by room on the market for a low-priced, relatively straightforward product (Section 2.1).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	4	4	0	1	4	4	4	0	2
Str.	0	0	0	1	1	2	0	0	2

Table 4 Evaluation of the *Overshot Customers* Force

According to Vorbrig, Polpoudenko, D´Hauwers, Koenig and Custeau it is a fact that the OSS systems of a CSP contain unnecessary software (Table 4). First, the OSS systems have accumulated software for up to 15-20 years and because there is no short term incentive to cut away unused functionality, the software keeps accumulating.

Secondly, vendors try to keep their offering wide, which in the multisystem and multivendor environment of today's operator leads to a situation where there often exist several software modules that could be used to perform a single process task.

Thirdly, Polpoudenko pointed out that if a system does not satisfy their needs and they have to implement a proprietary system for a task, also the commercial system will exist if it is purchased as an integral part of a bigger system. For example, MegaFon has implemented their own configuration management system, but there is also an unused commercial system for the same purpose installed.

Finally, Koenig identified the following explanation. Quite often the persons who purchase software for CSPs are not the end-users of the systems, and also the product managers of NEPs and IOVs who make the functionality decisions in their enterprises might miss practical hands-on view and perspective for the actual usage of the systems. This leads unavoidably to the implementation of some software that either is not needed or does not work in a proper way to be usable.

Interestingly, Schmidbauer and Pasonen do not agree that there could be much unused software. According to Schmidbauer there might be some graphical user interfaces that are nice for marketing although the operating personnel normally prefer the faster command line interfaces. According to Pasonen, there is no unused functionality because no one pays for it. The difference can be explained by the different point of view. From the vendors' point of view, a piece of software is in use when someone uses or has used it, or has at least paid for it. However, the same piece of software might be shipped as part of a system, also to many other customers who do not actually use it.

Only added complexity and the cost of integration were mentioned, by Koenig and D´Hauwers respectively, as pain points caused by the unused functionality. No-one regarded the force as a source of disruption and thus *Overshot Customers* is not classified as a force driving disruption in the OSS industry.

The absence of a visible drive for low-end disruption that could be expected based on the theory of Christensen and co-workers (2004) can be explained by the laws of the software business. The direct variable cost of delivering unused software is zero and the other cost elements related to unused functionality are even together too small to drive an industrial change. According to D´Hauwers it is also a general practice that customers pay only for the software that they need, i.e. in the business-to-business environment the customers cannot be forced to pay for unnecessary features.

5.2.2 The Integration Cost Force

The *Integration Cost* is related to the seemingly high 300% integration cost of the OSS systems that is even estimated to increase (Section 3.6.1).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	1	3	0	4	3	4	4	3	3
Str.	1		0	2	2	3	0	-2	2

Table 5 Evaluation of the *Integration Cost* Force

The discussion was started by asking the interviewee to comment the statistics of Gartner (Figure 10, page 41) presented by the interviewer. The existence of substantially high integration cost was accepted by all the interviewees, but the opinions about its role and importance varied a lot (Table 5).

According to the software vendors Schmidbauer, Koenig, Custeau and Pasonen the integration cost is very high. As expressed by Koenig: “The glue costs much more than the parts!” This view is easy to understand if we assume a roughly fixed overall OSS expenditure by the CSPs: a major improvement in the integration efficiency is the only way that could allow significant increase in the OSS software expenditure. A radical improvement in the integratability could even enable multiplied software expenditure and still decrease the overall OSS cost.

According to Pesonen, the main integration effort is in integrating a new OSS system to the administrative back office systems, not the integration to network elements or to other OSS systems. This is caused by the fact that the back office systems are often old and proprietary which leads to CSP-specific design and integration work. According to Pesonen, the costs are in balance.

Polpoudenko said that the share of the costs does not seem right, but would look nicer if it were the other way round. However, as he was not directly involved, nor up to date on OSS integration costs of MegaFon, he was not willing to comment on the consequences of the cost balance. From this we could draw the conclusion that the OSS integration cost is not an issue on his top priority list.

According to Vorbrig the costs as estimated and forecasted by Gartner are quite accurate and in balance. Towards the end of the period he also estimated the integration cost to increase even though not necessarily as rapidly as Gartner had forecasted four months earlier. In addition to him also D´Hauwers and Custeau expected the OSS integration cost to increase during the coming years.

Willetts, who is continuously in touch with the CEOs of the world’s leading CSPs, had an interesting view. According to him, the CEOs have now paid attention to this disproportionate cost element and are willing to act. He also identified a new stabilizing force (see Section 5.5.1 The Tailoring for CSPs) closely related to the integration cost.

Pasonen surprisingly saw the *Integration Cost* as a strong stabilizing force. The reasoning is that once a piece of OSS software has been integrated to the overall communications system it is not replaced without very good reasons. With integration cost typically exceeding the cost of software by three, this point of view is easy to accept.

As a conclusion, *Integration Cost* shall be classified as a major disruptive force (Strength 3) if the CSPs will pay strong CEO level attention to this and co-operate. Because the co-operation and attention have to last several years, nothing has been publicly announced and the OSS co-operation has been traditionally difficult for the CSPs (refer to the structure and regulation of the industry discussed in the Sections 3.4, 3.5 and 5.4.1) this has to be treated at the moment as an low probability event (Probability 1).

The NEPs and IOVs are likely to continue their co-operation and will try to identify ways to convert integration cost to software sales. However, without support from the CSPs they are not likely to succeed (refer to the next Section 5.2.3, especially to the view of Schmidbauer).

5.2.3 The Repeated Middleware Effort Force

The *Repeated Middleware Effort* refers to the parallel implementation of similar, OSS specific, but not yet a differentiating software layer by all the NEPs and several IOVs (Section 2.5.5).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	0		2	4	0	4	3	1	0
Str.	0		2	2		3	1	1	0

Table 6 Evaluation of the *Repeated Middleware Effort* Force

According to the interviewees, in theory all the systems could use technically similar or even the same OSS middleware. However, according to Pasonen the usage of external OSS middleware could be considered by an IOV only if all the following conditions are fulfilled.

1. The layer is provided as a piece of open, commercial software, i.e. the IOVs have access also to the source code.
2. The price of the software layer is significantly below the cost of one’s own implementation. As this layer is already implemented by the existing IOVs the price of the software layer and the transitions costs would have to be significantly below the maintenance cost of one’s own implementation.
3. The IOVs can fully trust that the middleware software is available also after 10 years. Pasonen is willing to trust only a company for which the middleware is the main business because in that case, for example the company’s internal refocusing operations are less likely to hit the availability of the product.

The last two criteria together form a difficult equation. The price should be low, but at the same time the company should be able to generate enough revenue from this software layer to safely survive possible recessions. NEPs as possible providers of the middleware layer, Pasonen excluded firmly, as an example of companies where an internal focus shift can discontinue even a profitable business.

The other IOV representative Custeau was more positive. A transition to a common middleware layer will take place, but a differentiating layer will always stay there, i.e. this transition will not be a significant disruption (Table 6). As a possible source for the middleware, Custeau named open source software (Section 5.3.4).

Schmidbauer had been personally involved in the CO-OP (Co-operative OSS Project) of TM Forum where NEPs work together in order to create a common architecture for mobile network management (Co-operative OSS Project [homepage on the Internet] c2006. Available from: http://www.tmforum.com/browse.aspx?catID=2272). Based on his experiences, it is very unlikely that the NEPs together would be able to specify a viable architecture, at least without the CSPs and SIs.

Vorbrig, D'Hauwers and Willetts were of the view that in order for a common middleware layer to emerge, the major CSPs had to drive it together and they did not consider this likely to happen in the near future. There are several other issues on the CSPs´ execution list prior to this.

Koenig saw this development natural, but through the ongoing mergers (Section 3.2), i.e. the consolidation of the NEPs will lead to 4-6 middleware layers in the NEPs' OSS systems instead of the current dozen.

Based on the view shared by Schmidbauer, Vorbrig, D'Hauwers and Willetts concerning the importance of CSPs in the process and especially on Vorbrig's pessimism about the likelihood of their participation as a conclusion, the *Repeated Middleware Effort* is classified as a low probability force (Probability 1). Referring to Custeau's view about the conservation of a separate differentiating layer the strength is classified as a minor disruptive force (1).

5.2.4 The Nonconsumers Force

The *Nonconsumers* refer to the new-market disruption where an existing product is made available to customers who do not have otherwise access to it due to cost or difficulty of usage (Section 2.1). In this study, this force includes also possibilities to use OSS for new purposes by slightly modifying it.

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	0	4	4	4	3	3	4	2	0
Str.	0	3	3	1	3	2	1	1	0

Table 7 Evaluation of the *Nonconsumers* Force

Pesonen listed several areas where a CSP could use the OSS type of software if it would be available. The first was fault finding software to encode and make available the knowledge of the best experts through step-by-step dialogs to all the personnel including the help desk. More than 80% of the cases are bulk problems that suitable software could easily localize and even instruct an employee to perform the corrective actions. Corrections on-line would significantly improve the end-user experience and the experts' time could be dedicated to the really difficult problems with the initial tests results already available.

The work of experts would also be made more efficient by performing the initial steps exactly according to the best known process (whereas today there are unavoidable variations in the daily actions of the hundreds of help desk employees). Also, clear statistics generated by the system would enable a CSP to optimize its systems and improve the corrective processes.

As the main reasons for commercial unavailability of these systems, Pesonen estimated the concentration of every NEP and IOV on their own specific selected technologies or manufacturers, whereas Elisa would need one single system to manage the whole infrastructure. Average fault correction time and cost is an essential competitive factor between today's CSPs! In the current situation CSPs are forced to develop this kind of functionalities by themselves. Schmidbauer supported this view by saying that proven and off-the-shelf systems with real end-to-end approaches are not available on the market.

As the second area of improvement, Pesonen listed that the level of self-service in the systems should be increased. Instead of reactive finding of existing faults, the OSS systems should proactively search for equipment that is about to deteriorate, for example, through automated nightly test rounds. Polpoudenko had a very similar need to proactively correct problems prior to the detection by the end-users. Although relevant and important requirements, in this study the proactive testing and correction functionality is classified as a sustaining innovation, i.e. something likely to be provided by the existing strong vendors without room for industry disruption (Section 2.1).

Thirdly, Pesonen highlighted the opportunity to further streamline existing processes through automation. All too often and still today, a maintenance person calls another person who uses a system in order to access or modify information. Direct, often remote, access by the initial person to the data would be faster, save the other person time and the effort of synchronizing the work of these two would not be needed. The main reason for the unavailability of this functionality is likely the concentration of vendors to selected technologies or manufacturers. This need is categorized as a sustaining innovation like the second area of improvement.

Finally, Pesonen listed a simpler OSS system where all the elementary functions would work very reliably, i.e. a basic system that would have implemented the proven tasks in such a way that it could very satisfactorily be used as basis for advanced higher level systems and enable a CSP to focus on other issues. This requirement is discussed more in Section 5.2.6 The Maturation of Communications.

Polpoudenko also listed several areas of needed functionality. First, an inventory system that could automatically manage, on plug-in unit basis, the serial number, manufacturer and installation engineer information. Second, performance management data, which would be comparable over different manufacturers and possibly collected using probes to harmonize the data and decrease data collection load in the network elements. Third, a system to distribute and manage network elements’ software modules and their versions. Fourth, a configuration management system that would allow the division of the management responsibility, on an individual parameter basis, between the radio network planning and optimization departments of MegaFon.

The common denominator for Polpoudenko's requirements is that although something like the above might be available, his need is *a company wide solution, i.e. across different technologies and vendors*. For example, at the moment he would like to manage Nokia's mobile network and Siemens' fixed network with a single system. This new disruptive force is discussed more in Section 5.3.2 The Umbrella OSS.

Not one of the interviewees mentioned the cost of OSS software as a barrier for using such software when available. Although the situation in the countries with very low labor cost might be different, it seems evident that at least in the western countries tasks implemented with software are always more efficient than manual work.

As Willetts foresees a major change in communications during the next five years (Section 5.1), he expects that the investment level to the current network technologies including their OSS systems might soon drop very low, leaving no funds for the development of major new functionality related to the current infrastructure.

According to Vorbrig, all the most important functionalities are available but the total number of OSS systems required to implement these is too high. He saw a clear quest for the reduction of the overall amount of systems (Section 5.2.6).

D'Hauwers and Pasonen estimated remarkable opportunity if the OSS systems can be harnessed much more closely, than is the situation today, to support business and end-users (Section 5.3.3).

Custeau estimated still remarkable potential for efficiency improving OSS software, but saw the inertia of the traditional telecom organizations as the main reasons why new software solutions are not introduced. Koenig supported this view, but saw as the main reason the difficulty to integrate new solutions to the legacy back office systems. These views are discussed as a new stabilizing force in Section 5.5.2.

The summary is that there is a demand for a simpler overall OSS architecture and more straightforward OSS systems as its components. This is very much in line with the theory of Christensen and co-workers (2004, 20-23) concerning the nonconsumers. However, as the cost of delivering already implemented software systems is close to zero (development costs sunk, no variable costs) the availability of funding to re-implement existing OSS functionality in a more efficient way is hard to find.

As a conclusion, *Nonconsumers* is classified as a low probability (1) force. As the re-implementation would not allow beating the existing systems in price, but only in more reliable functionality, the strength is classified as a minor disruptive force (1).

5.2.5 The Network Management Outsourcing Force

Network Management Outsourcing refers to the recent development where NEPs have started to operate the networks on behalf of the CSPs (Section 3.6.4).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	3	2	1	4	2	3	3	2	
Str.	2	2	2	2	2		2	2	

Table 8 Evaluation of the *Network Management Outsourcing* Force

D'Hauwers estimated that the outsourcing of network management activity is dependent of the development of the MVNOs. If their number continues to increase also the outsourcing of operations by the real operators, CSPs will continue.

Vorbrig and Schmidbauer described an organizational reason to outsource: if you can not drive through difficult mandatory changes in the organization, outsource and let another company to streamline. "Touch the untouchables", Schmidbauer. Often also the employees are more flexible towards a change in an outsourcing situation. The former estimated outsourcing to start from the access network, the latter predicted green field operators to lead the development. See Section 5.5.2 for more discussion on the organizational inertia.

As main reason for the NEPs' drive to host operations Schmidbauer considered the achieved lock-in, i.e. stronger position as the CSP's future network element provider. The second drive is the CSPs push for OPEX savings. The actual cost of operations can indeed decrease, if the outsourcing leads to fewer users of OSS systems and thereby to the harmonization of the systems. Finally, Schmidbauer estimated that the outsourcing of operations will lead to the end of in-house development (which is still to some extent continuing) of OSS tools by CSPs.

Vorbrig saw outsourcing also as a vehicle to transform CAPEX to OPEX and to get rid of NEPs' yearly OSS system upgrades that are expensive, but do not provide much new functionality. As a consequence, he estimated the need for better integration of OSS to the business management systems, and for development of strong service level agreements (SLA) and key performance indicators (KPI), which would enable a quantifiable inter-company interface between the outsourcing CSP and the hosting NEP.

Custeau assumed the outsourcing to continue strongly and as a consequence NEPs to become the future main clients of IOVs instead of the CSPs and saw an acute need for building their relationships to NEPs as customers. For example, in Australia the discussion with Alcatel instead of Telstra (Telstra selects Alcatel for network transformation [homepage on the Internet] 2005. Available from: http://fibers.org/articles/news/7/11/12/1). However, Custeau did not estimate that outsourcing would change the purpose or tasks of the OSS systems.

Pasonen interpreted outsourcing as a purely economical question. CSPs make their decisions based on the cost-efficiency of the ongoing cases. Decisive is the process knowledge of the outsourcing company: if their processes are significantly more efficient the outsourcing will continue. Polpoudenko estimated outsourcing as a vehicle to transfer best practices quickly globally from one CSP to another and thus possible to provide by the global NEPs, if they will be able to successfully manage the process and competence transfer between sites.

Pesonen had an opposite view. He estimated outsourcing to cease as competition intensifies and quality and cost-efficiency of the operations become even more important competitive factors between the CSPs.

Based on the observers of this development, i.e. D'Hauwers, Koenig, Custeau and Pasonen, the force is more likely than unlikely even though also the scenario presented by Pesonen is possible. Thus *Network Management Outsourcing* is classified with a high probability (3), but not as a definite force. It seems to have disruptive impact but will not according to any interviewee change alone the industry structure (Table 8). Therefore its strength is classified as a medium disruptive force (2).

As a consequence of possible outsourcing, Polpoudenko estimated that the NEP who provides the service will dictate the further development of the OSS, i.e. on a single CSP level outsourcing is always a major disruption.

5.2.6 The Maturation of Communications Force

Maturation of Communications refers to the OSS consequences of the maturing life cycle phases of its parents: the communications and the communications infrastructure industries (Sections 3.1 and 3.2).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	4	1	3	4	4	4	3	3	4
Str.	3	1	3	1	3	3	3	3	3

Table 9 Evaluation of the *Maturation of Communications* Force

According to all but one interviewee, *Maturation of Communications* has either a high probability or is definite (Table 9) and the ongoing mergers (Section 3.2) are evidence of it. For them, the question is more about the OSS consequences of this shift.

According to Polpoudenko, without Wi-Fi and WiMAX (In-depth Wi-Fi Information [homepage on the Internet] c2006. Available from: http://www.wi-fi.org/knowledge_center_overview.php; WiMAX (WiMAX Technology [homepage on the Internet] 2006. Available from: http://www.wimaxforum.org/technology) the communications industry would be maturing. However, he was not sure if these new technologies, which require more packet switched data processing capabilities, will be from the OSS point of view just additional technologies or drivers of more fundamental changes.

According to Vorbrig, this change is intensified by the overheated optimism about 3G and other new technologies in the end of 90's. The burst of the bubble dropped the estimated future revenues rapidly and made the turn to maturity significantly more rapid. According to him the OSS development has been always driven by a strong, OSS-external force. For example:

1. Marketing, customer needs or opportunity for additional revenue,
2. Technology refreshment in the overall infrastructure, or
3. Automation of the operators' processes.

Because these needs are not present as visibly as earlier the OSS investment budget will become scarce.

Pesonen saw development, for example, in the areas of xDSL speeds increasing from 8 to 24 Mbps and wireless broadband connections coming to laptop computers, but according to him there is no technical driver to significantly boost OSS development. Instead he saw maturation leading to cost-efficiency pressure that can be managed only with technology and vendor independent overall systems. Today the IOVs are often focused around one product, the NEPs are interested about their network elements and the overall, integrating OSS layer is not being provided by anyone (Sections 5.3.2).

According to Pesonen, the basic volume operations shall become extremely streamlined and the self-service of the network equipment has to become a reality. For example, significant amount of the corrective actions should take place automatically without any human interference (Section 5.2.4).

Vorbrig also estimated that companies that concentrate either on OSS software development or on OSS integration will be more likely to survive than those trying to do both. A system integrator who also tries to sell one's own components is always biased and lacks the efficiency of clear, company-wide priorities.

Pasonen estimated that although the price of calls has already dropped significantly and some of the CSPs feel considerable pain, there is still much room for reduction. For example, the mobile communication rates in Germany are still double the Finnish rates even if in a more densely populated major market they could be lower. The valid final price is cost plus industry specific profit, that in the communications could end up being around 6%.

Based on Polpoudenko's estimation, the *Maturation of Communications* is classified not as definite but with a high probability (3) and as a major disruptive force (3). It can be also split to its two main impact components the first of which can be called *Decreasing Development Budget* with a high probability (3) and as a major disruptive force (3). The second is the quest for an *Umbrella OSS* solution that would provide technology and a vendor independent upper management layer. The latter is discussed more in Section 5.3.2.

5.2.7 The Fixed Mobile Convergence Force

Fixed Mobile Convergence refers to the possible merge of different communication technologies (Section 3.1.4).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	3	4	4	4	2	4	3		4
Str.	2	3	2	2	2	3	3		3

Table 10 Evaluation of the *Fixed Mobile Convergence* Force

Koenig listed two main drivers for the convergence. *Full service integration* means that the services provided to an end-user are the same, regardless of the delivery vehicle. This objective requires very strong linkage between the networks used to provide the service and easily leads to full integration of the systems. According to Custeau, *the dream of mobility* would become true by the availability of the services at any time and anywhere, with the system hiding the complexity of routing and using always the most cost-efficient way to provide the services. This was also the vision of Polpoudenko based on the end-users' need for simplicity and quality even though he estimated especially the anywhere component to be difficult to achieve.

According to Koenig, the second main driver for convergence is the integration of CSPs' order fulfillment and service assurance processes in order to improve their efficiency. D'Hauwers estimated also the need for one, simple CSP wide fulfillment process to drive the integration of the OSS systems. Schmidbauer estimated huge OPEX savings if one single system could be used to provide all the communication services.

D'Hauwers said that the IMS has been accepted by the industry as the technical aid to achieve the convergence of different technologies and networks. According to him, only possible teething problems of the first IMS systems can slow down, but not prevent the development. Also Pasonen regarded IMS as the technology that will rewrite and merge the communications.

According to Pasonen, the amount of information will explode with IMS, because a typical IMS call generates ten times more data than a GSM call. The amount of items to be processed by an OSS system in a typical network could therefore increase from 10^9 to 10^{10}.

Vorbrig confirmed that Vodafone is shifting its strategy from wireless to converged services. Schmidbauer estimated the IP and telecom convergence to start from the core networks, but to extend also to the radio network in the long run.

According to Schmidbauer, IP adds one more technology and from the OSS point of view increases complexity even though all networks would be based on one IP trunk technology. He underlined that OSS alone cannot improve the quality of the current IP communications to the telecom level, but also the elements and the overall network architecture has to develop in order to the achieve credible quality status in the eyes of the end users. Willetts estimated the Multiprotocol Label Switching (MPLS) (Multiprotocol Label Switching [homepage on the Internet] 2006. Available from: http://www.ietf.org/html.charters/mpls-charter.html) to be the winning technology to transfer a wide variety of services over a single infrastructure.

During the interview D'Hauwers highlighted several times that the transition which transformed the IT industry to separated horizontal layers ten years ago is now going to repeat itself in communications. The main thing is transition from vertically integrated systems to layers. The exact structure of the layers was less interesting for him, but he drew a picture anyway to illustrate one possible scenario (Figure 15):

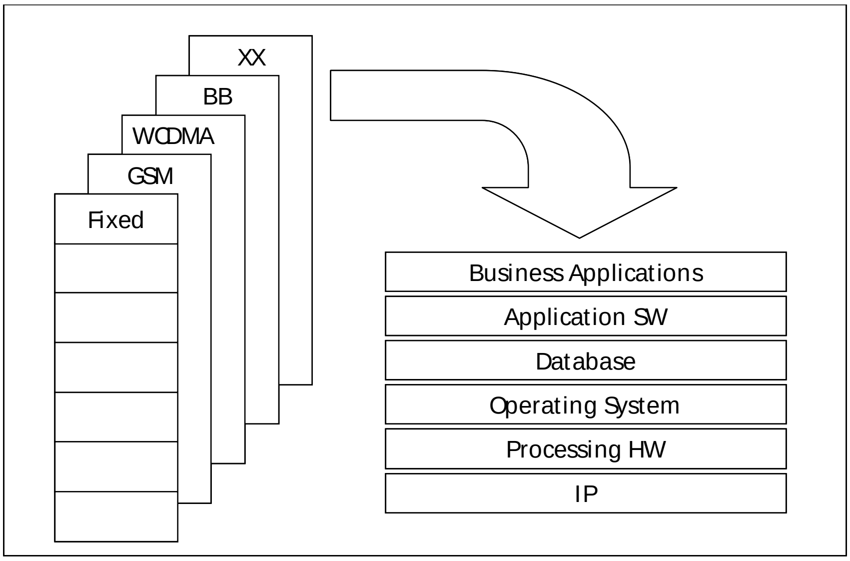

Figure 15 Example of Layered Communications Architecture

D'Hauwers said that currently the communications industry is on a development path where costs increase fast in relation to the declining revenues, and the question is when proactive companies decide or reactive companies are forced to make an investment to new technologies (layering, IMS) in order to secure the future profitability (Figure 16).

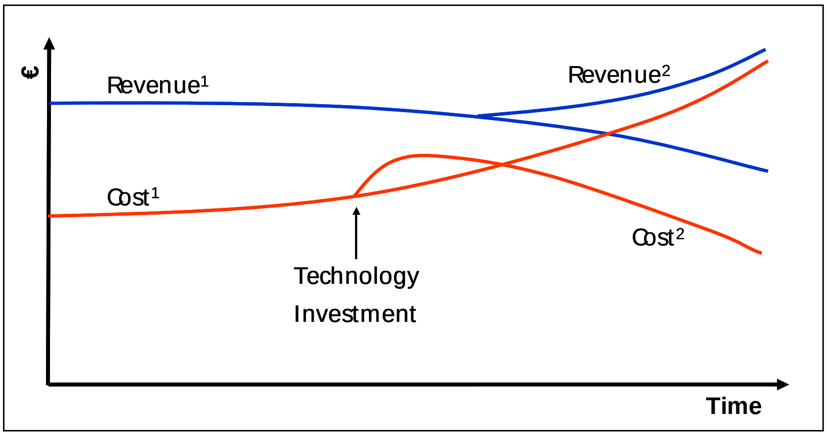

Figure 16 Time to Invest

According to Pasonen the missing of a well-defined, horizontal architecture is an essential stabilizing force in the industry.

Schmidbauer estimated the IT vendors' stake in the communications industry to increase. Due to the increased hardware processing power and development of the software, the generic purpose IT systems can be increasingly used in the communications for purposes that have traditionally required much more expensive industry specific solutions. This development might bring with itself a horizontal overall architecture that changed the IT industry.

In general, no one estimated that convergence would be limited to the fixed and mobile networks, but all the services including, for example video, will merge to one single system. In this study, all convergence forces are summarized (Table 10) and the force is renamed to *Convergence of Services*, which very probably will be enabled by IMS. The force has a high probability (3) and is a major disruptive force (3) as it will once more change the communications industry.

Layering of Communications is separated to its own force. As a new overall communications architecture would definitely require full OSS redesign and facilitate the entry of IP and IT management companies, the strength of this force is classified as a major disruptive force (3). Although D'Hauwers is very confident about this change its probability is estimated as medium (2). There are strong economical and technical reasons supporting the transition, but it would also be a fundamental change for the NEPs and it is questionable how far this transition will make it by 2010, if ever forcefully commenced.

5.3 Identified New Disruptive Forces

This chapter presents the main interview findings and the conclusion for each new disruptive force identified during the empirical phase.

5.3.1 The Flexible, Modular OSS Force

Koenig saw a very firm development towards smaller operative organizations driven ultimately by the intensifying competition and OPEX pressure in the communications industry. In addition to fewer personnel, this will lead to merging of different departments and will create an enormous pressure to decrease the number of different OSS systems and to integrate them more seamlessly.

As a solution to implement an incredibly flexible OSS, Koenig introduced the componentization of the current OSS systems to smaller building blocks. For example, instead of a fault management system, there would be different, separate components for its parts like alarm correlation. The main reason for incompatibility of the current OSS systems is formed by the different processes, data models and existing systems of the CSPs, but perhaps on the lower level the smaller building blocks are more similar and thus easier to integrate and reuse.

The overall consolidation of CSPs and NEPs and the continuation of outsourcing (Section 5.2.5) could lead to more harmonized overall architecture facilitating the componentization. According to Koenig, the IOVs would like to decrease their integration effort and concentrate more on the main business, i.e. software development. This *Flexible, Modular OSS* might enable this by transferring more integration burden from IOVs to the users of the OSS modules.

In general, Schmidbauer estimated upper level co-operation and compatibility possible, but forecasted the element manager level to stay proprietary.

Componentization is an interesting architectural idea and would inevitably have a major impact on the industry structure. Therefore the strength of *Flexible, Modular OSS* is classified as a major disruptive force (3), but because no one else mentioned this, a common movement is not yet on its way and the force is classified with low probability (1).

5.3.2 The Umbrella OSS Force

Polpoudenko and Pesonen expressed a strong need for a technology and vendor independent OSS system that would cover the OSS needs of a CSP (Sections 5.2.4 and 5.2.6). D´Hauwers said that HP would be able to provide this integrating, overall *Umbrella OSS* system. It differs from the *Flexible, Modular OSS* in the sense that an integrating umbrella layer covering all the OSS systems and providing an integrated access to the network would be sufficient. The modular solution would be probably more efficient, but also more demanding to achieve as it requires changes in every module. Therefore the strength of *Umbrella OSS* is classified as a medium disruptive force (2).

The *Convergence of Services* (5.2.7) would naturally lead to the convergence of the related management systems. Here it is estimated to increase the probability of Umbrella OSS from low to high (2). However, as the need for an overall OSS solution has been on the wish list for 15 years and there is no evidence for a strong movement, it is not reasonable to estimate the probability any higher.

5.3.3 The Respect for End-User Force

Internet companies like Google and Yahoo divide their clients to micro segments and also treat them individually in order to focus advertisement and to serve them proactively. For this purpose they collect, store and process significant amount of client specific information. (Custeau 2006)

In maturing communications markets, the cost of acquiring new subscribers increases while the revenue generated by these additional customers decrease when observed on floating average basis (Figure 17). Custeau paid attention to the fact that if the customers can be divided to micro segments and treated accordingly, the profitability of additional customers would continue much further. Even more important would be the opportunity to turn also the existing clientele more profitable through personalized service.

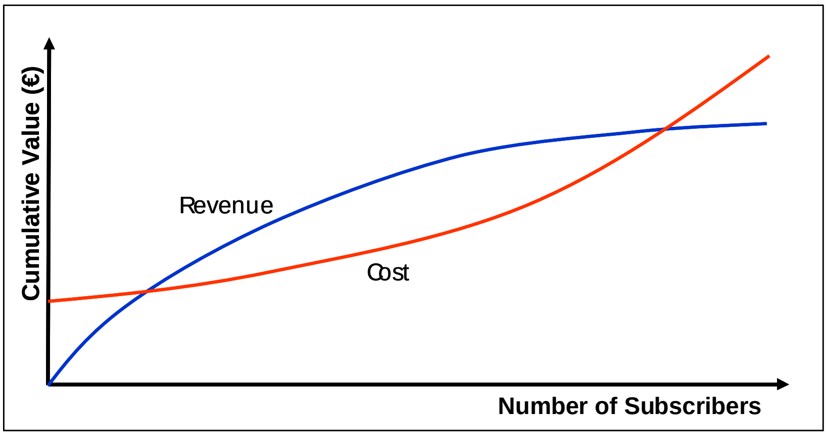

Figure 17 Cumulative Profitability of New Subscribers

According to Custeau, OSS will have an essential role in serving these micro segments individually, for example, by prioritizing corrections according to the impacted customers. He estimated also the other electrical ways of the Internet to treat customers individually to enter communications and provide opportunities for OSS. RoI calculations to justify these investments are straightforward. Willetts continued by mentioning the explosion of the device types and number of devices as an area where OSS could take a role close to the customers.

As the second example, Willetts paid attention to Wi-Fi development that can lead, in five years, to wireless connection of all home electronics. In such a situation, a capable management system will be needed in order to manage the overall communications and to localize faults in a variety of complex set-ups in every home. Again, this is a huge opportunity for OSS to move closer to the end-users and the focus of the business.

Finally, Willetts said that many of the new technology entries fail due to unsatisfactory end-user experience caused by bad initial quality of service. He forecasted that this phenomenon could be overcome by embedding a *quality of service module* to each device to monitor and inform the CSP about the actual service quality received by a specific user.

Pasonen said that people have more money to spend than ever before which gives room for new interesting services. He saw analytical CRM as the OSS related area where a working solution would be of high value.

According to Vorbrig, customer retention is one of the four reasons for which he could increase OSS investment budget. Polpoudenko and Pesonen would both like to have functionality to identify and correct problems proactively before the subscribers even notice them. In general the intensified competition and decreased margins (Sections 5.2.6) push CSPs to focus on their primary sources of profit, where the center place is reserved for the end-user. OSS proposals that support this goal are likely to succeed.

As a conclusion *Respect for End-User* is classified with a high probability (3) and as a medium disruptive force (2). The strength is not estimated as a major disruptive force (3) because there is no evidence that this goal would require fundamental changes to the existing systems.

5.3.4 The Open Source Software Force

According to Custeau Agilent is already using open source software to some extent and he described a few reasons why the OSS usage of open source software could increase.

- New versions of open source software become typically available more frequently, i.e. the software follows better the pace of technology development.
- Interfaces of open source software are more open. There is no need to try to protect them for business reasons and availability of the source code and possible integration kits helps the integration.
- Open source could eliminate some pieces of undifferentiating software that IOVs and NEPs develop in parallel (Section 5.2.3).

As an example Custeau mentioned that when Agilent replaced a commercial ORB (Object Request Broker) implementation with the open source IONA ORB (IONA Open Source Solutions [homepage on the Internet] c2006. Available from: http://www.iona.com/solutions/opensource/?WT.mc_id=123463) they learned that in addition to the open source benefits, the IONA ORB was also technically better.

According to Custeau, OSS systems are mission critical which means that open source software can be utilized on the edge of the system, but the core functionality will always be commercial software. This naturally significantly reduces the disruptive strength and it is classified as a minor disruptive force (1). Because no one else mentioned open source software, its likelihood as a disruptive force in the OSS industry is classified as one with low probability (1).

Typically, the open source phenomenon accelerates and intensifies itself when more vendors start to develop products for it (Martin Fink 2003, 10). Therefore, the *Open Source Software* force can be expected to get stronger towards the end of the study period.

5.3.5 The Common Enemy Force

One root cause for missing structure (Section 3.4) and weak regulation (Section 5.4.1) in the OSS industry is formed by the low willingness of the CSPs as competing companies to co-operate and steer the industry. However, now Schmidbauer raised up low price internet calls as a common enemy that could push CSPs to co-operate more closely on every area that would lead into decreased OPEX.

Willetts supported the view and mentioned Skype as a special threat with its totally free computer to computer calls (Skype. Koko maailma puhuu ilmaiseksi [free translation: "Skype. The whole world talks free of charge"] [homepage on the Internet] c2006. Available from: http://www.skype.com/intl/fi/). Polpoudenko mentioned that it is possible to call from a computer anywhere in the world to a mobile in Russia for two US cents per min.

From the OSS point of view this force has to first push the CSPs who can then possibly impact the OSS companies. Because of the derived nature, the strength of *Common Enemy* is classified as a medium disruptive force (2) and not strong. As there is no visible evidence for the actions of the CSPs and in the past their co-operation has not been easy (Sections 3.4, 3.5 and 5.4.1) the probability is classified as low (1).

5.3.6 The OSS Cost Ratio Force

According to Pasonen, the OSS systems of today are all the time getting more complex and expensive as new OSS functionality and support for new communications technologies are incrementally added, but nothing is taken away nor the overall OSS architecture rewritten. At the same time, the cost of equipment is decreasing due to the hardware price erosion and especially due to the ongoing convergence (Section 5.2.7). As a consequence of this, the relative cost of OSS versus the cost of the managed network is rapidly increasing (Figure 18).

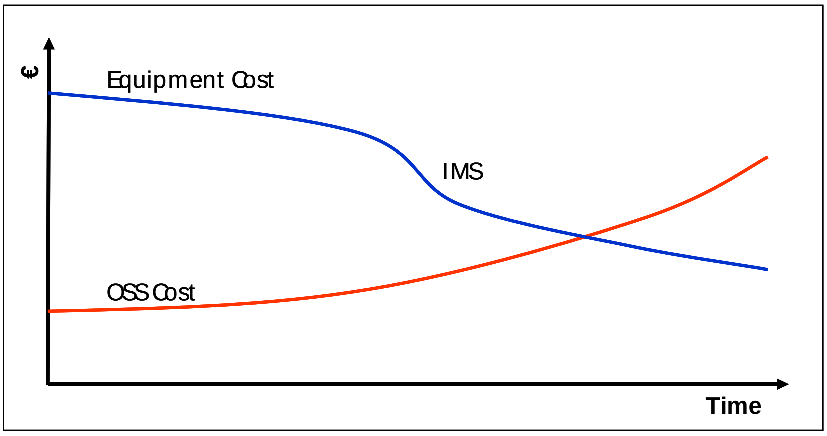

Figure 18 OSS Cost Ratio

For Pasonen the question was does this ratio reach a point when it will be paid strong attention (by the CSP CEOs) and acted on, or does the development continue and lead eventually to a situation where one key criteria for the selection of network technologies and elements would be their OSS cost?

D'Hauwers also paid attention to the increasing cost of management and argued that it cannot continue very long, but is actually one factor leading to the layering of the overall communications architecture (Section 5.2.6).

Custeau said that convergence (Section 5.2.7) will lead to a situation where the price of OSS is compared to the significantly lower management cost of the IP and IT systems. This will make the deteriorating *OSS Cost Ratio* to look even worse.

As summary the increasing trend of the proportional OSS cost is a fact. The likelihood of it getting forcefully addressed by 2010 is not low because of its significance as justified above. However, it is also is not very high because top-level CSP co-operation will be again required. Therefore the force *OSS Cost Ratio* is classified with medium probability. The strength is estimated as a major disruptive force (3) because a significant cost decrease will call for major actions, for example, a fundamental redesign of the overall OSS architecture.

5.4 Evaluation of Theory-Based Stabilizing Forces

This chapter presents the main interview findings and a conclusion for each stabilizing force based on the created theoretical framework (Section 3.7).

5.4.1 The Weak Regulation Force

Weak Regulation refers to the loose or missing OSS related regulation and standardization (Section 3.5).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	4	2	4	4	3	4	3	3	3
Str.	-3		0	-3	-3		1	-3	-3

Table 11 Evaluation the *Weak Regulation* Force

All but one interviewee regarded *Weak Regulation* as a fact, but the opinions about the impacts and desired state of the regulation and standardization varied significantly (Table 11).

Vorbrig considered OSS regulation and standardization missing and regarded this as one major force that slows down industry development. According to him, suitable interface standards would essentially accelerate the development and significantly speed integration of systems.

According to Polpoudenko and Koenig the OSS regulation is derived, i.e. there are no direct requirements, but OSS may be needed as a tool to deliver, for example, legally required data like network coverage statistics for government or stock exchange.

Polpoudenko appreciated TM Forum’s enhanced Telecom Operations Map® (eTOM) (eTOM [homepage on the Internet] c2006. Available from: http://www.tmforum.org/browse.aspx?catID=1647) as a very good standard and tool to model operations. He did not consider OSS standardization as strong, but anyway useful and existing for certain areas. Polpoudenko and Koenig both did not have a clear opinion whether a certain level of standardization is accelerating or slowing down the industry development.

Pesonen said that good interface standards would enable more efficient operations between companies. For example, if Elisa leases a broadband access port from a local telephone company for its customer, it is not exactly clear how to monitor the quality of the service provided or to identify who is responsible to troubleshoot and correct possible problems. However, Pesonen did not regard *Weak Regulation* as a disruptive or stabilizing force.

Schmidbauer regarded the existing standards so abstract that they do not bring the desired compatibility. Also, according to him, some integration will be always needed even if the standardization would proceed significantly. Finally, he doubted how strong standardization commitment the base station sales-oriented NEPs are willing to make: integration costs are paid by the CSPs and provide lock-in.

D'Hauwers considered standardization between layers (Section 5.2.7) as a mandatory prerequisite for development, as long as missing these standards indeed prevent the transformation. However, D'Hauwers was confident that if the standards required to efficiently separate different layers do not emerge through official standardization, a few major companies will establish together the required de facto standards (Gawer & Cusumano 2002, 41). The expectable industry efficiency improvement is big enough to drive this change trough via one route or another. Standards would also drive down the integration cost (Section 5.2.2).

According to Pasonen, regulation comes typically late, but at arrival, forces the companies to adapt rapidly and creates a strong impact. For example, the legislation for the number portability between operators in Finland came late, but strongly intensified the competition. He continued that in the OSS industry, the traditional standardization is dead and replaced by de facto standards agreed between strong players based on commercial reasons.

The view of Custeau was that tighter control would slow down development of the industry and that *Weak Regulation* is actually a disruptive force.

Because regulation and standardization does not provide for most of the interviewees the rules and limitations they would expect it normally to provide, the *Weak Regulation* force has a high probability (3).

The decision of what the impacts of this force to consider in the overall disruption analysis is more difficult. In a disruption study, the reasonable selection is to go for the strongest effect that is the prevention of the transition to the layered architecture as presented by D'Hauwers. The strength of this must be considered as a major stabilizing force (-3), especially when we include the general view concerning standardization by Vorbrig to this impact.

The rest of the presented views are interesting, but do not represent especially strong forces nor were supported by more than one interviewee. Therefore they are omitted on the summary level.

5.4.2 The High Failure Penalty Force

High Failure Penalty is related to the possible hesitance of the CSP to make OSS related changes as they might have an impact also on the much more valuable overall communications system (Section 3.6.2).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	0	0	3	4	2	4	3	0	1
Str.	0	0	-2	-2	-2	-3	3	0	-1

Table 12 Evaluation of the High Failure Penalty Force

Vorbrig did not consider *High Failure Penalty* as a stabilizing force any more (Table 12). Earlier this was an issue, but today the big CSPs test changes in one region and after that roll them out to the proven part in a sequential way.

Polpoudenko did not consider this as a force because OSS is always behind the network elements in development and he would actually roll new functionality out faster, if it would be available. For him, the important thing is to maintain visibility to the network and possible other problems have much lower impact.

For Pesonen, this was an issue and he mentioned one example where an upgrade in the OSS system stopped an entire technology segment. The problem is that the network is active all the time and therefore after quite a short period of time, the roll-back of a new OSS software version is troublesome.

According to Koenig, the fear of failure slows down the roll-out of OSS functionality. The difference in the viewpoint could be explained by the fact that Koenig was working in a NEP position quite a few years ago.

Schmidbauer also was confident that the risk of failure is a significant force. This might be explained by the fact, that as a vendor, the CSPs will push him for very reliable deliveries and upgrade processes, even if they do not internally consider this as strong reason to slow down OSS development.

D'Hauwers did not consider OSS as a product, but it is a system that is evolving all the time and that might have problems, if you upgrade its pieces, or if you slow down the installation process of the newest functionality. Therefore he did not consider the risk of failure as a stabilizing force.

A very contradictory view was held by Custeau, who saw OSS as an opportunity to get more benefits out from the infrastructure and expected the OSS release adaptation speed to increase (as its value is better understood and utilized), i.e. this is surprisingly a disruptive force.

For Pasonen the issue was not the risk of failure, but he illustrated the scenario related to the cost ratio of OSS and network elements (Section 5.3.6).

Based on two CSP interviewees considering the *High Failure Penalty* as not an issue but one regarding it as a medium force, as a summary it is classified as medium (-2) stabilizing force with a low probability (1).

5.4.3 The Cost as Part of Infrastructure Force

Cost as Part of Infrastructure refers to the possible phenomenon that when OSS is purchased as part of a sizable network deal, it does not get an appropriate focus, but the buyers concentrate on the more expensive parts of the total contract (Section 3.6.2).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	0	0	2	4	3	4		2	3
Str.	0	0	-2	-1	3	-2		2	-2

Table 13 Evaluation of the *Cost as Part of Infrastructure* Force

According to Vorbrig this is not an issue. OSS is part of the selection criteria and gets the appropriate attention when Vodafone is purchasing equipment (Table 13).

Polpoudenko said that this used to be a problem, but now MegaFon has a separate Operations and Maintenance department to participate in the procurement process and it gets the appropriate support and respect from the other departments.

Pesonen's view was that the situation at Elisa has improved as the OSS functionality and the high availability of the overall solutions now gets better attention. However, he still considered this as a stabilizing force.

According to Schmidbauer's experience, today's buyers are capable and are moving their focus from total cost of ownership to *total value* which he defined as *the generated revenue minus the total cost of ownership*. However, the CAPEX still gets remarkable attention and the OSS systems are difficult to compare, whereas the key features of a base stations might be defined with a few numerical values, which tends to focus the buyers towards the network elements.

D'Hauwers forecasted the focus on OSS to increase, especially if the value of OSS for the business can be better articulated. So this will, in fact, be a disruptive force.

According to Koenig, this force is strong. However, probably his view was based on his experiences at Lucent years ago.

Pasonen referred to his view about increased OSS versus equipment cost (Section 5.4.2) and articulated that if not now, then anyway in the near future, OSS should start getting remarkable attention of the buyers.

The conclusion is formulated according to the CSP representatives who have direct and up-to-date information. *Cost as Part of Infrastructure* is a diminishing force and is classified with low probability (1) and as a minor stabilizing force (-1).

5.4.4 The NEP Profits Force

The key idea of *NEP Profits* is that the OSS business would be so profitable that it would make the NEPs protect the current structure of the OSS industry (Section 3.6.2).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	0		4	0	1	4	0	2	0
Str.	0		3	0	-1	0	0	1	0

Table 14 Evaluation of the *NEP Profits* Force

Pesonen estimated that the OSS business could be very profitable for NEPs because there are several operational areas where the CSPs could achieve significant savings with suitable software (Table 14). As an example, he mentioned a big regional CSP where customer service costs could be easily reduced by 50 million euros on yearly basis with relatively simple software to automate and streamline the process. He said that probably 25 million euros could be charged for that type of functionality, a price which would be much beyond the software development cost. However, his opinion was that the OSS business would not be a significant profit generator for the NEPs at the moment.

Koenig recalled a breakthrough about 7-8 years ago, when the equipment prices had declined to so low a level, that the OSS systems could not anymore be given out for free in order to win business, and the NEPs had to start selling them separately. However, Koenig did not foresee that this profitability would steer NEPs to do anything special in order to protect their OSS income.

Vorbrig and Willetts did not consider the OSS business especially profitable for the NEPs. Schmidbauer, D'Hauwers and Custeau had the same opinion about it currently, but they estimated that in the future, OSS as a major software business, could become profitable for NEPs because it does not have similar price erosion that is typical for hardware. However, this would require significant NEP focus on OSS, in order to learn the business logic of this value-adding layer.

Pasonen did not know, but figured that NEPs could be actually drawing themselves away from the OSS business, i.e. that it is not especially profitable for them and this is actually a light disruptive force.

As a conclusion, the *NEP Profits* is not a force that would be stabilizing the OSS industry at the moment.

5.4.5 The SI Revenues Force

SI Revenues is based on the assumption that the high OSS integration income of the SIs would make them to protect the current industry structure (Section 3.6.1).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	3			4	2	4	0		
Str.	-2			-1	-1	0	0		0

Table 15 Evaluation of the *SI Revenues* Force

Koenig estimated, based on his view covering several companies, that the OSS system integration is a sizable revenue generator, but not especially profitable. The reason is that each integration task is a bit different and is under time pressure. Time pressure is caused by the normal situation where the systems have been purchased and should be integrated for production as soon as possible.

The difference is caused by the fact that the software modules (or their versions to be integrated) are always a bit different and also the tailoring for the CSP in question has to be taken into account. Small companies do not have enough similar tasks to learn effectively and big companies have to work globally, which leads to rapid rotation in the teams.

Together the time pressure and the variance between tasks prevent the reuse of integration code and thus opportunity for special profits. Finally, a serious integrator has to invest significantly CAPEX into suitable laboratories as development and testing environments and global operations will cause remarkable travel costs.

Finally, Koenig rejected the idea of *SI Revenues* as stabilizing force in the OSS industry by comparing it to glue. If the parts can be connected somehow without the glue, the glue cannot do anything to prevent it. D’Hauwers supported the view by regarding integration work as profitable, but SI companies unable to prevent possible development in the OSS industry towards better integratability.

Schmidbauer regarded integration work as profitable but evaluated it as only a minor (1) stabilizing force (Table 15). Custeau’s view was that building and providing overall solutions is profitable, not just the integration work alone.

As a conclusion, *SI Revenues* is not a stabilizing or disruptive force in the OSS industry.

5.4.6 The Replacement Costs Force

Replacement Costs refer to the additional costs like integration, process change or training caused by a change in the OSS system (Section 2.6).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	3	2	4	4	2	4	0	3	2
Str.	-2	-2	-2	-2	-2	-3	0	-3	-2

Table 16 Evaluation of the *Replacement Costs* Force

All but one interviewee regarded *Replacement Costs* as a stabilizing force that slows down the development and sets a threshold level for new systems, i.e. they have to significantly improve in order to be considered (Table 16).

Pesonen was especially skeptical concerning the hassle related to the introduction of multivendor management systems. Polpoudenko had the view that investments have to be amortized before they can be replaced with new systems.

Custeau did not consider *Replacement Costs* as a stabilizing force, but based on his experience, due to the existing problems in the systems, the CSPs are willing to replace if the change is properly proposed and supported by clear value argumentation.

Based especially on the CSP representatives view, the conclusion is that *Replacement Costs* is classified with a high probability (3) and as a medium stabilizing force (-2).

5.4.7 The Missing Leadership Force

Missing Leadership refers to the lack of a recognized leader in the OSS industry (Section 3.4.3).

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*
	Global CSP	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*
Prob.	4	2	2	4	3	4	3	3	3
Str.	2	2	-2	-2	-2	-3	1	-1	2

Table 17 Evaluation of the *Missing Leadership* Force

According to Willetts and Aho (2006a) there is a 100 million US dollars revenue growth barrier for IOVs in the OSS industry. This is caused by the phenomenon that the industry can be seen as a composition of about 10-11 different segments, for example, the segments of optimization and inventory management. The segments are so diverse that it is difficult to be successful in several segments at the same time and because in each segment there are 3-4 strong players the maximum revenue for a single IOV remains limited. In addition, the NEPs take a slice out of the OSS industry's total external software revenue of about 4 billion euros (Section 3.6.1).

Koenig considered OSS industry as incredibly fragmented (Section 5.5.1 The Tailoring for CSPs) without any visible leader (Table 17). He strongly did not see NEPs as potential leaders. The other NEPs have to be able to trust the leader as a company providing *fair and open access* to the relevant information which can never take place in a directly competitive situation. Therefore the leader has to be an independent company.

Custeau listed strong companies in the industry in the following order: Amdocs, Telcordia, IBM Global Services, Accenture, HP and the NEPs. He expected the industry also to stay fragmented and estimated that strong leaders would create inertia, i.e. *Missing Leadership* is actually surprisingly a disruptive force. According to him, SIs are in a strong position, due to their best overall offering and close customer intimacy, which is based on consultation.

D'Hauwers considered the current OSS market too fragmented and estimated that the ongoing consolidation would improve the industry. However, according to him no one company could acquire enough companies to become a sole leader, but most likely the next step would be that a few major companies will form an alliance in order to steer the industry (a 40-50% combined market share would be needed for this).

It is very clear that an industry transformation is ongoing with the big players acquiring OSS companies in an accelerating manner. The following examples were raised by the interviewees.

- EMC acquired Smarts for 190 million euros in December 2004 (EMC to Acquire SMARTS [homepage on the Internet] 2004. Available from: http://www.emc.com/news/emc_releases/showRelease.jsp?id=2836&l=en&c=US).
- IBM acquired MicroMuse for 730 million euros in December 2005 (IBM to acquire MicroMuse [homepage on the Internet] 2005. Available from: http://telephonyonline.com/finance/news/ibm_aquires_micromuse_122105/).
- Amdocs acquired Cramer in July 2006 for 290 million euros (Amdocs Completes Acquisition of OSS Solutions Provider Cramer [homepage on the

Internet] 2006. Available from: http://www.cramer.com/content.asp?Ref=1-2-1&NewsID=219).

- HP acquired Mercury for 3.6 billion euros in July 2006 (Roberts, Paul F. [homepage on the Internet] 2006. Available from: http://www.infoworld.com/article/06/07/26/HNhpmercury_1.html?APPLICATION%20MANAGEMENT).
- Oracle acquired MetaSolv in October 2006 (Oracle Buys MetaSolv Software [homepage on the Internet] 2006. Available from: http://www.oracle.com/corporate/press/2006_oct/oracle_metasolv.htm).
- IBM acquired Vallent in November 2006 (IBM to Acquire Vallent [homepage on the Internet] 2006. Available from: http://www-03.ibm.com/press/us/en/pressrelease/20682.wss).

Pesonen said that an industry leader is a company that anticipates the needs of its customers and providers solutions proactively. He did not consider the NEPs as this type of actor. In addition, he said that the NEPs tend to have problems with their internal information flow, i.e. their departments work independently as silos.

As a company with significant foothold, Pesonen mentioned HP. He was especially happy with the flexibility and innovativeness of the best small companies. As an example, he mentioned SMARTS.

Polpoudenko appreciated TM Forum and especially eTOM as direction setters for the industry. He estimated that in the future Chinese companies would be very strong in hardware, Indian companies to take the leading role in software, but also considered Russia as a country with possible foothold in both.

Vorbrig estimated that the Chinese companies would continue increasing their share on the equipment market. According to him, no full OSS provider exists, but he mentioned IBM, HP and Amdocs as strong players. However, he estimated that there would be a separate battle for the leadership of each 10-11 segments and typically 2-3 leading companies could emerge per segment. The industry would be much healthier and faster in this kind of a setup, than if controlled by only one leader. As an example, he mentioned the amount of time that Microsoft needed to develop the Vista operating system release after Windows XP: which was over five years (Windows XP Is Here! press release on the Internet] 2001. Available from: http://www.microsoft.com/presspass/press/2001/oct01/10-25xpoverallpr.mspx; Get

Ready for Windows Vista [homepage on the Internet] c2006. Available from: http://www.microsoft.com/windowsvista/getready/default.mspx).

Schmidbauer said that the leader can be only a company who can co-operate with the CSPs and the OSS vendors. Co-operation or gaining an even stronger grip inside any single industry player type is not enough in order to lead the overall industry. At the moment he did not regard any company in the leading position.

According to Pasonen, there is currently no leader in the OSS industry, but he listed Amdocs, Oracle and SAP as companies who could strengthen their position in the future. According to his opinion the leader absolutely cannot be one of the NEPs as they are not able to co-operate. Actually, he was expecting the NEPs possibly to withdraw from the OSS business (Section 5.4.4).

Pasonen valued the work of TM Forum and said that its authority has increased a lot during the past four years: “It is a strong and important body respected by the OSS companies.” Pasonen concluded that a leader could accelerate the development, but a too strong leader would probably throttle it. As an example, for a too strong industry leader, he mentioned MicroSoft.

Willetts discussed extensively the leadership in the OSS industry. Amdocs has 13% market share, Telcordia 4% and the rest are smaller (Market Share, Global OSS Supplier Market Leadership in 19 Segments, 2006, 1). TM Forum has 550 member companies (Our Members [homepage on the Internet] c2006. Available from: http://www.tmforum.org/browse.aspx?catid=737) out of which 300 generate less than 30 me in revenue. Amdocs is very strong in billing, but generates remarkable share of its revenue through tailoring of the billing solutions and has not been very active in the other segments. Telcordia is relatively big and has strong software engineering skills, but has not visibly taken a direction to lead the industry. So, at the moment there is no leader. Speculatively, he presented the following companies as leader candidates for the future.

1. IBM is doing acquisitions frequently, but might as well be after telecom skilled software engineers as it is striving for a position in the OSS industry and it is very strong in services software.
2. Oracle would be a candidate based on its strong software skills.
3. MicroSoft, as a candidate, can never be ruled out based on its success and strong cash position. However, there are no clear signs that MicroSoft would enter the OSS market.
4. HP could be a strong candidate, but has had the tendency to hesitate how much and whether to invest in OSS.
5. Sun is a company that has hesitated whether to focus on hardware or to have a strong position in the software.

As a rank outsider he mentioned the Indian and Chinese, and also the Russian, family owned companies that might have the financial resources and long enough patience to keep investing in OSS, until a leadership position has been gained. It is important to note that even if the listed companies are not biased, in the sense that they would sell network elements like the NEPs, they all are profit-seeking enterprises with agendas to maximize their revenues.

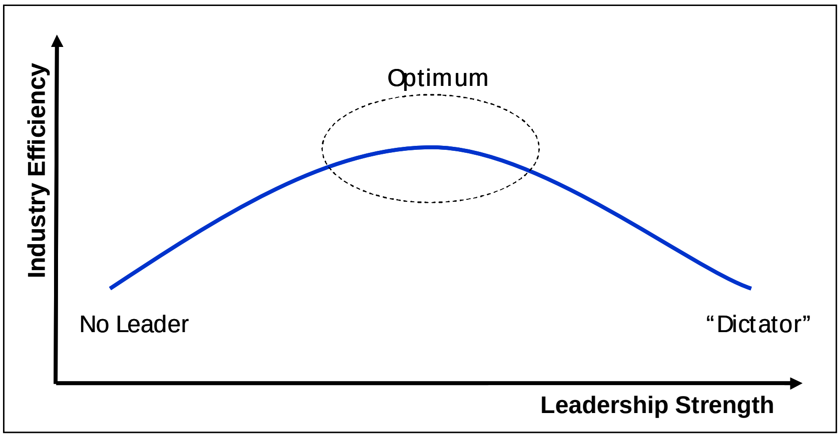

Figure 19 Optimal Leadership According to Pasonen

The discussion concerning the accelerating or decelerating impact of a leader can be summarized repeating the view of Pasonen (Figure 19). At the moment, we are on the very left and thus a stronger leader would be good for the industry, but after some years of development we might reach the optimal position, after which the further strengthening of the leaders, would have a negative overall impact. As the time span of this study is limited until 2010, *Missing Leadership* is a stabilizing force.

Koenig paid attention to the common purchasing policy of the CSPs to use multiple, at least two, sources for critical elements. This makes it difficult for anybody to gain a very high market share and become a “dictating” leader simply by winning deals. In addition, authorities responsible for free competition will prevent mergers that would lead to a similar situation.

As a conclusion, *Missing Leadership* is classified as a definite (4) force and as medium stabilizing force (-2). It does not alone prevent the industry development, but will significantly slow it down. How the battle for leadership will proceed and who is going to win remains to be seen. Very likely it is not going to be one of the NEPs or an IOV concentrated to one of the industry segments.

5.5 Identified New Stabilizing Forces

This chapter presents the main interview findings and the conclusion for each new stabilizing force identified during the empirical phase of the study.

5.5.1 The Tailoring for CSPs Force

Willets saw *Tailoring for the CSPs* as one root stabilizing force in the OSS industry (estimated Probability 4, Strength 3). The reason is that many CSPs are enormous companies, and even if there might be a mental commitment for the usage of *off-the-shelf software*, in practice in purchasing situations the CSPs easily ask for tailoring in order to fit the product into their processes and existing system. And because CSPs are important customers for NEPs and IOVs, they do tailoring, sometimes even free of charge in order to get a deal. With zero variable costs it is better to do even remarkable tailoring that also creates a lock-in for the deal, than loosing the deal completely.

Schmidbauer supported this force by considering tailoring as one weak lock-in vehicle for the NEPs (estimated Probability 4, Strength 1). Koenig shared the view of Willetts and said that without CSPs’ stronger respect for standards, the fragmentation of the OSS industry will never go away.

As a conclusion, *Tailoring for CSPs* is a definite (4) stabilizing force in the industry. If a portion of the CSPs would respect standards and give up tailoring that would be enough to create a movement for better and faster integrability in the industry. Therefore, the strength is estimated only as a medium stabilizing force (-2).

5.5.2 The CSPs' Organizational Inertia Force

Custeau said that often the most challenging part of an OSS project is the organizational inertia. Automation of processes requires lots of changes and co-operation in operator's organization that might have been operating so far in deep silos. For him, this was a definite and strong stabilizing force.

Vorbrig regarded *Organizational Inertia* as the key reason to outsource (Section 5.2.5).

Koenig said that CSPs are still using huge, old mainframe-based systems. According to Pesonen, integration to these systems is a major part of the integration cost (Section 5.2.2). In this study, the CSPs slowness to replace soon obsolete systems is included to *CSPs' Organizational Inertia* when it decelerates the overall industry development.

As a conclusion, *CSPs' Organizational Inertia* is classified as a high probability (3) force and as a medium stabilizing force (-2). It slows down development, but does not prevent it.

5.6 Evaluation of the Theory Based Bidirectional Force

One bidirectional force, *New Communication Technologies*, was identified in the theory phase of the study (Section 3.5). If the inflow of new communications technologies is so strong that the frequent upgrades of the OSS system take all the energy and no focus is available to develop the overall system itself, this is a stabilizing force. If instead each change can be benefited by improving also the overall system in connection to upgrades accommodating the new technologies, this is a disruptive force.

	Vorbrig Global CSP	Polpoudenko Reg. CSP	Pesonen Nat. CSP	Schmidbauer NEP	D´Hauwers MSW, SI & ITV	Koenig SWS, NEP	Custeau IOV	Pasonen IOV	Willetts IO
Prob.	0	1	3	4	3	0	4	0	2
Str.	0	-1	-2	-2	3	0	-2	0	1

Table 18 Evaluation of the *New Communication Technologies* Force

Vorbrig estimated HSDPA (High Speed Downlink Packet Access) to bring a couple of new parameters and metrics. WiMAX is a bigger change, but limited to access part of the network. In general he did not see that the inflow of new technologies would accelerate or decelerate the development of the OSS.

According to Polpoudenko, MegaFon establishes a new division to roll-out a major new technology and thus it does not impact the operations of the existing network. However, from time to time, there is a situation when the focus is on the roll-out which takes the attention away from the development of the overall system for a while. Thus, this is a light stabilizing force (Table 18).

Pesonen's view was similar, i.e. from time to time there are new technologies, for example push-to-talk, but in general the inflow does not prevent the development of the overall OSS system.

Schmidbauer confirmed the continuous inflow of new technologies and added that they get also all the time more complicated. This view is easy to accept, as in the OSS unit of a global NEP who implements the majority of the new technologies, the inflow of novelties must be higher than for a single CSP. Thus this force impacts NEPs more than CSPs.

D'Hauwers' view was that in some point of time, adding new technologies on top of each other and making the OSS system all the time more complex will have to stop. It is namely, driving the cost of management versus the cost of equipment and revenue all the time in a worse direction (Section 5.2.6).

Koenig assumed the position of an end-user and concluded that as he does not experience a constant inflow of new services, also the CSP serving him cannot have this problem.

Custeau said that the service and business needs of a CSP dictate the frequency of technology introductions and OSS has to just adapt to them and synchronize the OSS specific development to these steps.

Pasonen's view was that OSS is anyway a constantly changing system and because a CSP does not take all the new technologies in use, but carefully selects some of them, this is not a force impacting the development of the industry.

As a conclusion, the *New Communication Technologies* is, from the OSS point of view, a stabilizing force that impacts some of the CSPs, most likely all NEPs and some of the IOVs. The probability is estimated as medium (2) and strength for CSPs' as a minor disruptive force (1). However, from the industry point of view, the pain is experienced by the NEPs and some IOVs where the strength is probably at least classified as a medium disruptive force (2), and maybe there are some OSS vendors where the accommodation of the new technologies actually takes all the development energy (major disruptive force). From the industry point of view this shall be interpreted according to the more capable companies, i.e. the strength is classified as a medium disruptive force (2).

5.7 Structure of OSS Industry

This chapter summarizes the findings concerning the structure of the OSS industry that was regarded to lack a common architecture (Section 3.4.1). The structure of the industry is naturally related to its missing leadership (Section 5.4.7).

Vorbrig regarded OSS as an industry with three layers and four roles. At the bottom, there are the NEPs with vendor specific OSS solutions. The second layer is formed by the traditional IOVs, for example, Remedy with its trouble ticketing system. The top layer is formed by companies with both system integration and product competencies, for example, HP and Accenture.

Pesonen said that there are single product vendors, NEPs with their element managers and companies with end-to-end testers like Agilent. However, the systems are not interoperable and the industry is missing an overall integrating layer.

According to Schmidbauer, there is no out-of-the box functionality or standards that would enable it. Every OSS is a customer project, and there is no prevailing industry structure.

D'Hauwers estimated that the NEPs could add value to their OSS by supporting network elements of some other NEPs. He said also that there are lots of niche companies on the market and that HP could provide a multivendor umbrella system to structure the industry and share part of the engineering cost (Section 5.3.2).

According to Koenig the OSS industry is incredibly fragmented. Custeau said that especially the small, independent vendors drive the change. He said that the CSP's own OSS development is decreasing and that the NEPs have two roles as the providers of the basic element management functionality and outsourcing services. The SIs are adding product competencies to their portfolios and could increase their overall importance in the future.

According to Willetts, TM Forum currently divides the OSS companies only to three categories: the CSPs, the OSS vendors (including the NEPs, MSWs and IOVs) and the SIs and does not try to further specify their roles, although in the selection of participants for the working groups they have an internal model of 10-11 segments. These segments, however, only divide the OSS vendors to sub-segments, but do not make the overall industry structure clearer.

As a conclusion, the OSS industry is missing a common structure. Also, there was no finding that would oppose the usage of the ITU-T model with three layers (Section 3.4.1) to describe the structure of the industry, which is therefore regarded as valid for the internal purposes of this study.

5.8 Non-Identified Forces

This chapter lists forces that could have surfaced in the interviews, but did not. There were several general questions and a few that directly asked for additional forces (appendix 4, part 5, especially the questions 5h-j) but still the following phenomena were not mentioned.

The Internet allows *new sales and distribution channels*. For example, Vodafone is procuring entire networks through e-auctions (Vodafone picks Nokia [homepage on the Internet] 2004. Available from: http://www.theage.com.au/articles/2004/05/10/1084041311036.html?from=storyrhs), but in general this is not happening in the OSS industry yet. It is very likely the weak standardization (Section 5.4.1) and the missing overall structure of the systems (Section 3.4.1) demand so much vendor-customer interaction that the person-to-person relationship-based selling is the only possible volume channel.

As the CSPs have started to outsource their network operations, the NEPs could also *outsource the OSS development*. Actually, NEPs use software subcontractors in their OSS development, especially the NEPs in the countries of highly salaried software engineers like in the United States. Yet, this was not mentioned by any interviewee as a force impacting the OSS industry. Probably the outsourcing or increased subcontracting of the OSS development does not have strong impact as long as the subcontractors stay in the implementation role and the NEPs continue specifying the functionality.

The transition from IPv4 to *IPv6 technology* has been discussed actively during the past years as an important step towards IP communications, and it actually provides considerable enhancements, for example to the security and mobility (Loshin, Pete 1999, 140-144 and 181). However, it was not raised up by any of the interviewees as a possible force.

Service-oriented architecture (SOA) has got a lot attention in the IT industry during the recent years. It is basically a set of evolving standards that enables more flexible interaction between the services on different IT infrastructure through specific middleware (The Middleware [R]evolution [homepage on the Internet] 2007. Available from: http://www.oracle.com/products/middleware/docs/mw-revolution.pdf). In theory, it could also essentially ease the integration and interaction of the OSS systems, but was not still raised by any interviewee. Probably, it is a relevant technology, but the main problems and focus in the OSS industry is still on the other issues.

For IPv6 and SOA the conclusion is that they may well appear and support the development of OSS. Nevertheless, they are not the key change forces.

It is important to note that the evidence for the insignificance of these forces as disruptive is much weaker than for those that have been explicitly discussed and disproved. However, apparently these forces are not on the top of the agenda for any of the interviewees.

5.9 Disruption Optimism

The theory work led by accident to the same number of disruptive and stabilizing forces and to one bidirectional force. Thus the interviewees were not given any hints to which direction the development would be going and this leaves an opportunity to analyze their assumptions.

	Vorbrig	*Polpoudenko*	*Pesonen*	*Schmidbauer*	*D´Hauwers*	*Koenig*	*Custeau*	*Pasonen*	*Willetts*	
Forces	*Global CSP*	*Reg. CSP*	*Nat. CSP*	*NEP*	*MSW, SI & ITV*	*SWS, NEP*	*IOV*	*IOV*	*IO*	*Average*
Disruptive	7	4	9	4	9	9	9	7	11	7.7
Stabilizing	4	1	5	5	4	6	2	3	3	3.7
Difference	3	3	4	-1	5	3	7	4	8	4.0

Table 19 Interviewees' Overall View on Disruptive and Stabilizing Forces

By counting the major (Strength 3) and medium (Strength 2) forces that each interviewee regarded to have at least a medium probability (2-4) for, we get a simple summary of the data (Table 19). On the average, the interviewees recognized 7.7 disruptive and 3.7 stabilizing forces.

Willetts said: "The industry will be totally different in five years." D'Hauwers estimated: "The change will accelerate and go faster." Custeau identified significantly more disruptive forces and believed that several changes about to start. Vorbrig also forecasted changes, but estimated them to be more evolutionary than rapid and interruptive.

All the interviewees, except Schmidbauer, identified clearly more disruptive forces. Also he was not against the changes, but foresaw several obstacles, i.e. stabilizing forces the disruptions must overcome.

As a summary, the interviewees expect 2007-2010 to be years of change.

6 SUMMARY AND CONCLUSIONS

This chapter recapitulates the study and summarizes the major forces in the OSS industry during 2007-2010 leading to the overall forecast for the industry. Final topics are to compare the theoretical and empirical results, discuss the generality of the findings and list a few tempting areas for further study.

6.1 Summary

This study was inspired by the recent advance in the industry disruption theories and the importance of the topic. Would it be possible to foresee these sudden, but fundamental changes which make newcomers to supersede prevailing empires and technical inventions to disperse globally?

OSS, one of today's major software industries, was selected as the case due to several alleged signals of change in the industry, and its familiarity to the investigator. The purpose of the study was to answer to the following questions.

Q1 Is there going to be disruptions in the OSS industry during 2007-2010?
Q2 What is causing or preventing these disruptions?
Q3 Are the generic industry disruption theories applicable to the OSS?

The study started with the adaptation of the generic industry disruption theories to the OSS environment (Chapter 2). The work of Clayton M. Christensen and co-workers (1997, 2003, 2004) was particularly used as the theoretical ground. Adaptation was required due to the business-to-business software nature of the OSS and its role as an integral part of the communications and communications infrastructure industries. Especially the following phenomena related to the former required adaptation: the incremental cost, the cost of unused functionality, the importance of architecture and the concept of middleware. The cost of replacing OSS systems is related to the latter. The theory work produced four candidates for the disruptive and stabilizing forces.

- Disruptive: *Overshot Customers* (Section 2.1)
- Disruptive: *Nonconsumers* (Section 2.1)
- Disruptive: *Repeated Middleware Effort* (Section 2.5.5)
- Stabilizing: *Replacement Costs* (Section 2.6)

The parent industries of the OSS, its state and outlook are discussed next (Chapter 3) leading to several additional industry force candidates.

- Disruptive: *Fixed Mobile Convergence* (Section 3.1.4)
- Disruptive: *Maturation of Communications* (Section 3.2)
- Disruptive: *Integration Cost* (Section 3.6.1)
- Disruptive: *Network Management Outsourcing* (Section 3.6.4)
- Stabilizing: *Missing Leadership* (Section 3.4.3)
- Stabilizing: *Weak Regulation* (Section 3.5)
- Stabilizing: *SI Revenues* (Section 3.6.1)
- Stabilizing: *NEP Profits* (Section 3.6.2)
- Stabilizing: *High Failure Penalty* (Section 3.6.2)
- Stabilizing: *Cost as Part of Infrastructure* (Section 3.6.2)
- Bidirectional: *New Communication Technologies* (Section 3.5)

The resulted fifteen industry force candidates are shortly described and depicted together in Section 3.7 (page 46). Next the theoretical model was further developed by interviewing nine senior industry participants for their views on the future of communications, the OSS industry and each of the forces. The methodology of this explanatory case study, its validity and reliability, and the approach used in the empirical phase are described in the Chapter 4. The following new industry force candidates were identified in the empirical phase.

- Disruptive: *Flexible, Modular OSS* (Section 5.3.1)
- Disruptive: *Umbrella OSS* (Section 5.3.2)
- Disruptive: *Respect for End-User* (Section 5.3.3)
- Disruptive: *Open Source Software* (Section 5.3.4)
- Disruptive: *Common Enemy* (Section 5.3.5)
- Disruptive: *OSS Cost Ratio* (Section 5.3.6)
- Stabilizing: *Tailoring for CSPs* (Section 5.5.1)
- Stabilizing: *CSPs' Organizational Inertia* (Section 5.5.2)

The main interview findings and the conclusion for each industry force candidate are presented in Chapter 5. Several forces were disproved as non-existent or non-relevant for the overall development of the OSS industry. The valid disruptive and stabilizing forces during 2007-2010 are summarized and depicted next (Q2) (Section 6.2). After that, the focus will be on the overall development of the OSS industry (Q1) (Section 6.3).

The partial suitability of the generic industry disruptions theories to describe the OSS industry (Q3) will be discussed (Section 6.4) before the limited generality of the results (Section 6.5) and identification of a few tempting areas for further study (Section 6.6).

6.2 Disruptive and Stabilizing Forces in OSS Industry

This chapter presents first the disruptive and then the stabilizing forces with major (3) or medium (2) strengths in the OSS industry during 2007-2010, in the order of importance (Figure 20). As this is a study about disruption, the forces with minor (1) strength will be from now on omitted. According to the definition they do not have disruptive impact (Section 4.2, page 51).

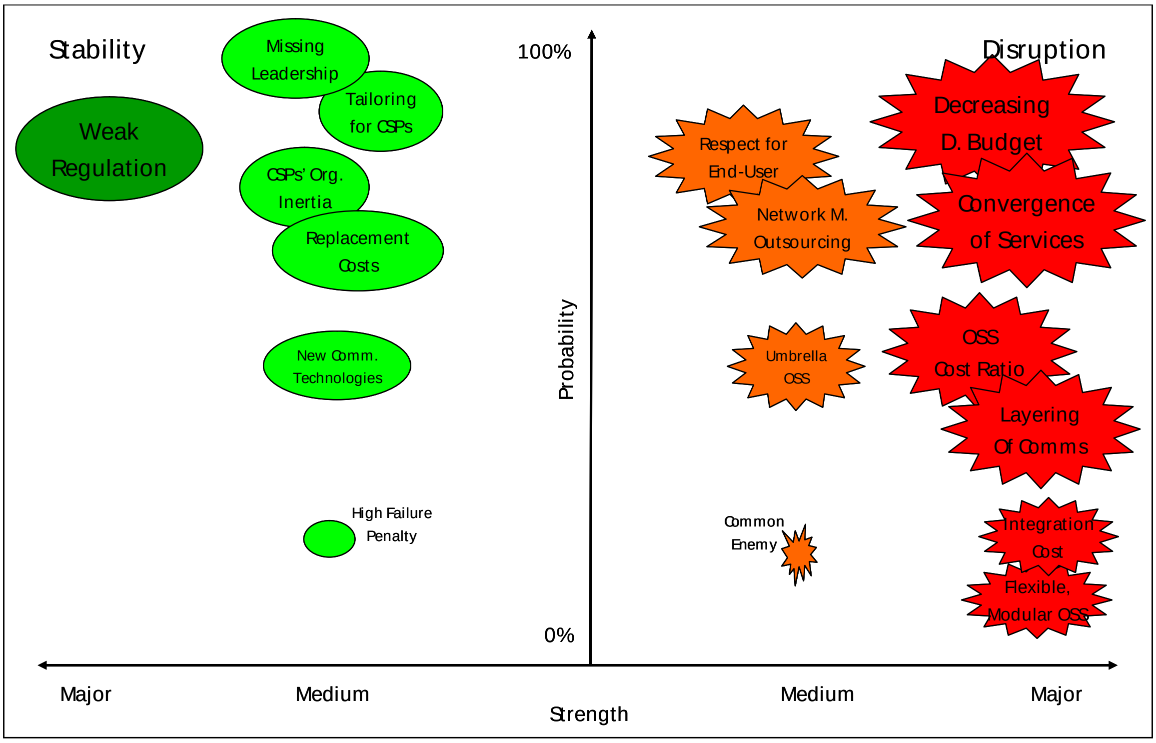

Figure 20 Disruptive and Stabilizing Forces in OSS Industry

The funding available for OSS development (the *Decreasing Development Budget* force) is very likely going to decrease as a consequence of the maturation of the communications industry leading to intensified competition and cost pressure. The innovations related directly to end-customers or yielding tangible business profits are the most probable to get funding. This decrease is going to be so deep that new development approaches are required for OSS companies to survive. Probability 3, Strength 3 (Section 5.2.6)

The communication networks are very likely to converge (the *Convergence of Services* force) IMS being the expected technology enabler. The new network cannot be managed with the traditional OSS systems, but a new approach will be required. Probability 3, Strength 3 (Section 5.2.7)

OSS Cost Ratio, i.e. the cost of OSS in relation to the cost of the managed elements will continue to increase. The OSS systems get all the time more complicated as new functionality and support for new technologies are added as incremental code without re-architecting the overall solution. At the same time hardware price erosion and *Convergence of Services* (Section 5.2.7) will significantly drive down the cost of the network elements. Convergence will also make the cost of OSS more directly comparable to the remarkably lower management costs of IP and IT systems. Probability 2, Strength 3 (Section 5.3.6)

The *Layering of Communications* is fundamental transition from vertical, single purpose communications systems to generic horizontal layers separated by well-defined standards enabling multivendor compatibility. This development would closely follow similar development in the IT industry ten years ago. It would require full OSS redesign and facilitate entry of IP and IT management companies to the OSS industry. Probability 2, Strength 3 (Section 5.2.7)

The *Integration Cost* of OSS, exceeding the value of the software by four and in slow growth, seemed to be on adequate level by the CSPs. Although OSS vendors would like to cut this costs and use part of the savings for additional software sales it is not likely to succeed without strong support by the CSPs. As this would require years of long strong CSP co-operation and CEO level attention the force has a low probability. However, if the transition will start, it will have a major impact. Probability 1, Strength 3 (Section 5.2.2)

One possibility to compose an extremely flexible OSS system would be to decrease the size of the building blocks to one step smaller modules. For instance, instead of a fault management system, its parts like alarm correlation would be the commercial components on the market. The transition of the industry towards *Flexible, Modular OSS* systems has a low probability, but would naturally cause a major disruption. Probability 1, Strength 3 (Section 5.3.1)

The focus on internal needs of intermediate companies of the communications value chain is likely to decrease and the needs of the actual end-users of the services are likely to intensify (the *Respect for End-User* force). Micro segmentation and device management are areas where good innovations are likely to be funded. Probability 3, Strength 2 (Section 5.3.3)

Network Management Outsourcing is likely to continue. The NEPs providing outsourcing services will significantly increase the volume of their network management operation thus de facto consolidating the OSS customer base. In order to become efficient the outsourcing companies will deploy similar, streamlined processes globally. Pressure for efficiency backed by their increased purchasing power is likely to make these companies to remarkably harmonize the future development of the OSS systems. Probability 3, Strength 2 (Section 5.2.5)

Efficiency pressure intensifies CSPs' requirements for an *Umbrella OSS* system to manage their networks with a single system covering all technologies, equipment types and vendors. Despite increased strength, *Convergence of Services* makes this dream technically easier and more likely to succeed. Probability 2, Strength 2 (Section 5.3.2)

A *Common Enemy* for the CSPs, namely the Internet calls and Skype, has emerged. The question is, does this force push the CSPs to work more closely together in order to improve their competitiveness and the efficiency of the OSS industry among other factors. The likelihood of co-operation is still estimated with a low probability and implications to OSS as medium because it is not yet known to where the possible measures would be targeted. Probability 1, Strength 2 (Section 5.3.5)

Weak Regulation and standardization is the first stabilizing force and explains to large extent the current incompatibility of the systems. If the standardization does not improve and lead to better interoperability of the OSS systems, for example, the transition to layered overall communications system architecture is not possible. TM Forum has gained more respect during the past few years, but there is still a long way to go and therefore this force shall be treated as strong. Probability 3, Strength -3 (Section 5.4.1)

The OSS industry is *Missing Leadership*. A leader to show direction in the industry can be only a company who is trusted by the other players which at the moment excludes the NEPs due to their strong internal competition and significant other than OSS interests. A leader would definitely increase the development speed of the industry, but a very strong leader could in the long run also throttle the innovativeness. It is difficult to ascend to leadership from one of the OSS industry's 10-11 subsegments and therefore current candidates are the companies, including IBM, HP, Amdocs and EMC, who have lately acquired several OSS companies. If no one will succeed, this force is likely to continue slowing down the OSS industry although TM Forum has gained respect during the past a few years. Probability 4, Strength -2 (Section 5.4.7)

Tailoring for CSPs refers to the phenomenon that although the CSPs on principal level might be committed to unaltered, commercial systems they ask in practical purchasing situations tailoring that the OSS vendors easily accept in order to get a deal and lock-in for the business. This tailoring is one fundamental reason for the fragmentation of the OSS industry. As requiring strong and long CSP CEO level co-operation to improve, the situation is likely to stay at it is. Probability 4, Strength -2 (Section 5.5.1)

The *CSPs' Organizational Inertia* refers to the fact that often the most demanding part of an OSS project is to get the CSP's organization to accept the change, modify the processes and use the new system in an optimal way. *Organizational Inertia* reflects also the possible tendency of decision makers to object changes. Probability 3, Strength -2 (Section 5.5.2)

Replacement Costs refer to the integration, training and process change costs related to the purchase of a new OSS system. They set a significant threshold to replace an existing system and will thus slow down the industry development although they do not prevent it. Probability 3, Strength -2 (Section 5.4.6)

New Communication Technologies flow in constantly and may eat a significant portion of the OSS development resources of NEPs and IOVs who aim to support most of the novelties. In extreme cases, this shifts focus away from the development of the OSS system itself. The CSPs do not suffer this so much as they deploy new technologies selectively and might have a separate organization to operate the existing network and pilot new things. Probability 2, Strength -2 (Section 5.6)

High Failure Penalty refers to the phenomenon that a CSP hesitates to make modifications to an OSS system in order not to risk the whole network in case of problems. This is a diminishing force due to the constant evolving nature of the OSS systems, testing facilities and sequential roll-out by the big CSPs. However, for some of the CSPs, this is still a force that slows down the development speed. Probability 1, Strength -2 (Section 5.4.2)

The presented forces correlate. For example, the *CSPs' Organizational Inertia* is slowing down the disruption caused by *Integration Cost*. This phenomenon in turn is addressed by *Network Management Outsourcing*. However, these correlations have not been the subject of this study, but form one possible interesting topic for further investigation (Section 6.6).

As a conclusion and answer to the question Q2, the forces above will cause and prevent the disruptions in the OSS industry during 2007-2010.

6.3 Disruptions or Stability?

The major disruptive forces of the OSS industry during 2007-2010 will be *Decreasing Development Budget* (high probability), *Convergence of Services* (high probability), *OSS Cost Ratio* (medium probability), *Layering of Communications* (medium probability), *Integration Cost* (low probability) and *Flexible, Modular OSS* (low probability). Medium impact will be caused by the increased *Respect for End-Users* and the continuation of *Network Management Outsourcing*.

The only major stabilizing force is *Weak Regulation* and standardization, but even that can be overcome by de facto standards (for example, Gawer & Cusumano 2002, 41). *Missing Leadership*, *Tailoring for CSPs*, *CSPs' Organizational Inertia* and *Replacement Costs* will have medium stabilizing impact.

As a conclusion and answer to question Q1, the OSS industry will experience several disruptions during 2007-2010. This was also supported by the interviewees' optimism concerning disruption (Section 5.9).

6.4 The Difference Between Theoretical and Empirical Results

There are six forces that were present in the theoretical model, but disproved in the empirical phase. The disruptive force, *Overshot Customers*, is suffocated by the very low cost of producing copies of existing software for new customers (Sections 2.1, 2.5.1 and 5.2.1).

The disruptive force, *Nonconsumers*, is not relevant by the very low cost of producing copies of existing software. In addition, there are several needs that require sustaining innovations, i.e. has a low probability to cause disruptions. The need for an essentially breaking innovation is categorized as the new *Umbrella OSS* force (Section 5.3.2). (Sections 2.1, 2.5.1, and 5.2.4)

The disruptive force, *Repeated Middleware Effort*, struggles with the missing trust of the other OSS vendors to one of them as provider of common software and with the low overall priority of this initiative in the industry. In addition, if implemented, the common middleware is not likely to cause a major disruption due to the remaining differentiating layers (Sections 2.5.5 and 5.2.3).

The CSPs have overcome the stabilizing force, *Cost as Part of Infrastructure*, by setting up separate OSS purchasing organizations that are also adequately involved in the decision making concerning total system procurement (Sections 3.6.2 and 5.4.3).

The stabilizing force, *NEP Profits*, is disproved by the missing evidence for the profitability and the likely focus of the CSPs on their volume business segments (Sections 3.6.2 and 5.4.4).

The weak means of the SIs to prevent industry development towards better integratability smother the stabilizing force, *SI Revenues* (Sections 3.6.1 and 5.4.5).

Both the theoretical and empirical phases were mandatory in order to understand the forces in the OSS industry. As a conclusion and answer to the question Q3, the generic industry disruption theories are applicable to the OSS, but require significant adaptation due to its several distinguished features.

6.5 Generality of Results

The results of this study are valid in the OSS industry (Section 4.4.3) and forecast its likely development during 2007-2010 based on the outlook at the time of the interviews that were held in November-December of 2006. The results cannot be generalized beyond the OSS industry, but include views that might be worth of consideration in the related or similar industries, for example, in the communications infrastructure industry, and in the industry of process automation operations systems like the operations centers for the paper mills.

6.6 Areas for Further Study

There is now a thin overall picture describing the forces to impact OSS during the coming years. It opens several interesting further research opportunities. It would be very natural to deepen the knowledge by studying the *relationships between the forces*: how they correlate or otherwise impact each other, will they be necessary or likely take place in a certain order, and what is their likely timing?

Another direct continuum would be to start a *longitudinal research* based on the created case study database (Section 4.4.4). The focus would be on the expected transitions in the OSS industry and on how well this study succeeded in describing them and why. Updating the theory part and repeating a comprehensive interview round every two years, i.e. 2008 and 2010 would likely catch the essentials. A slightly separate area would be to follow and analyze the *OSS industry leadership battle* that has just started with the accelerating acquisitions in the industry (Section 5.4.7).

The maturation of communications and fixed mobile convergence networks, and/or their OSS consequences, would be an interesting area to research. What are the main forces driving this development and is it likely to follow the patterns of similar industrial transitions in the past?

The coopetition (Yadong Luo 2004, 11) between the CSPs, that seems to form an essential enabling or preventing base for many changes in the OSS industry (Sections 5.2.2, 5.2.3, 5.3.5, 5.3.6, 5.4.1 and 5.5.1), would be a very tempting area for research based, for example, on the work of Adam M. Brandenburger and Barry Nalebuff (1997).

Finally, I want to wish best of luck to anybody who plans to dedicate his attention on research within this industry. It is a fruitful research area, especially based on the open-minded and friendly members of the community.

7 REFERENCES

Books:

Brandenburger, Adam M. & Nalebuff, Barry J. 1997: Co-opetition, A Revolution Mindset That Combines Competition and Cooperation, The Game Theory Strategy That's Changing the Game of Business. Australia: Currency. ISBN 1861975074.

Camarillo, Gonzalo & Garcia-Martin Miguel A. 2004: The 3G IP Multimedia Subsystem, Merging the Internet and the Cellular Worlds. United Kingdom: John Wiley & Sons Ltd. ISBN 0 470 87156 3.

Christensen, Clayton M. 1997: The Innovator's Dilemma, When New Technologies Cause Great Firms to Fail. United States: Harvard Business School Press. ISBN 0-87584-585-1.

Christensen, Clayton M., Anthony, Scott D. & Roth, Erik A. 2004: Seeing What's Next, Using Theories of Innovation to Predict Industry Change. United States: Harvard Business School Press. ISBN 1-59139-185-7.

Christensen, Clayton & Raynor, Michael E. 2003: The Innovators Solution, Creating and Sustaining Successful Growth. United States: Harvard Business School Press. ISBN 1-57851-852-0.

Cusumano, Michael A. 2004: The Business of Software, What Every Manager, Programmer, and Entrepreneur Must Know to Thrive and Survive in Good Times and Bad. United States: Free Press. ISBN 0-7432-1580-X.

Fink, Martin 2003: The Business and Economics of Linux and Open Source. United States: Pearson Education, Inc. ISBN 0-13-047677-3.

Gawer, Annabelle & Cusumano, Michael A. 2002: Platform Leadership, How Intel, Microsoft, and Cisco Drive Industry Innovation. United States: Harvard Business School Press. ISBN 1-57851-514-9.

Govindarajan, Vijay & Trimble, Chris 2005: 10 Rules for Strategic Innovators, From Idea to Execution. United States: Harvard Business School Press. ISBN 1-59139-758-8.

Hamel, Gary 2000: Leading the Revolution. United States: Harvard Business School Press. ISBN 1-57851-189-5.

Järvinen, Pentti & Järvinen, Annikki 2004: Tutkimustyön metodeista. Finland: Opinpajan kirja. ISBN 952-99233-2-5.

Loshin, Pete 1999: IPv6 Clearly Explained. United States: Morgan Kaufmann, Inc. ISBN 0-12-455838-0.

Luo, Yadong 2004: Coopetition in International Business. Denmark: Copenhagen Business School Press. ISBN 87-630-0128-4.

Messerschmitt, David G. & Szyperski, Clemens 2003: Software Ecosystem, Understanding an Indispensable Technology and Industry. United States: The MIT Press. ISBN 0-262-13432-2.

Moore, Geoffrey A 2002: Crossing the Chasm. Australia: Collins. ISBN 0060517123.

Moore, Geoffrey A 2006: Dealing with Darwin, How Great Companies Innovate at Every Phase of Their Evolution. United Kingdom: Capstone. ISBN 1-84112-717-5.

Mouly, Michel & Pautet, Marie-Bernadette 1992: The GSM System for Mobile Communications. France: the authors. ISBN 2-9507190-0-7.

Nagle, Thomas T. & Holden, Reed K.2002: The Strategy and Tactics of Pricing, A Guide to Profitable Decision Making, third edition. United States: Prentice Hall. ISBN 0-13-026248-X.

Ojanperä, Tero & Prasad, Ramjee (editors) 1998: Wideband CDMA for Third Generation Mobile Communications. United States and United Kingdom: Artech House. ISBN 0-89006-735-X.

Porter, Michael E. 1998. Competitive Strategy: Techniques for Analyzing Industries and Competitors. United States: Free Press. ISBN 0-7432-6088-0.

Shapiro, Carl & Varian Hal R. 1999: A Strategic Guide to the Network Economy. Boston, United States: Harvard Business School Press. ISBN 0-87584-863-X.

TEK, tekniikan tietokeskus, 1981. Finland: WSOY. ISBN 951-0-10886-3.

Terplan, Kornel 2001: Operations Support System Essentials, Support System Solutions for Service Providers. United States: John Wiley & Sons, Inc. ISBN 0-471-39240-5.

Standards:

Enhanced Telecom Operations Map, the Business Process Framework, Release 5.0, Version 1.4.1, April 2005. United States: TeleManagement Forum.

eTOM Hands-on Clinic 31.10.2005. London, United Kingdom: TeleManagement Forum & the Billing College.

GSM 01.02, General description of a GSM Public Land Mobile Network (PLMN), version 4.0.2, 1993. France: European Telecommunications Standards Institute.

GSM 12.00, Objectives and structure of Network Management, version 4.6.0, 1997. France: European Telecommunications Standards Institute.

GSM 12.01, Common aspects of GSM/DCS 1800 Network Management, version 4.4.1, 1996. France: European Telecommunications Standards Institute.

GSM 12.30, ETSI Object Identifier tree, Common domain, Mobile domain, Operation and Maintenance (O & M), managed object registration definition, version 4.2.0, 1995. France: European Telecommunications Standards Institute.

ITU-T Recommendation M.3010, Principles for a telecommunications management network, 2000. Switzerland: International Telecommunication Union, Telecommunication Standardization Sector.

ITU-T Recommendation M.3050.0, Enhanced Telecom Operations Map (eTOM), Introduction, 2004. Switzerland: International Telecommunication Union, Telecommunication Standardization Sector.

ITU-T Recommendation M.3050.1, Enhanced Telecom Operations Map (eTOM), the Business Process Framework, 2004. Switzerland: International Telecommunication Union, Telecommunication Standardization Sector.

ITU-T Recommendation M.3050.2, Enhanced Telecom Operations Map (eTOM), Process decompositions and descriptions, 2004. Switzerland: International Telecommunication Union, Telecommunication Standardization Sector.

Industry Reports:

Detailed Global OSS Forecast of 19 Segments, OSS Observer: November 2005. United States: OSS Observer.

Dittberner’s Examination of Nokia’s OSS Middleware Proposal, White Paper 2005. United States: Dittberner Associates, Inc.

Ericsson Annual Report 2000, published 2001. Sweden: LM Ericsson.

Ericsson Second Quarter Report 2003, published 2003. Sweden: LM Ericsson.

Ericsson Annual Report 2005, published 2006. Sweden: LM Ericsson.

Fixed Mobile Convergence, Business Opportunities, Trends and Market Approaches in the Global Market Place, 2006. United Kingdom: Informa Telecoms & Media.

Forecast, Broadband Access Systems, Worldwide, 2004-2010, September 2006. United States: Gartner.

Forecast, Carrier Network Infrastructure, Worldwide, 2001-2010, December 2006. United States: Gartner.

Global Mobile Market Forecast, 2Q06 Update, June 2006. United States: Yankee Group Research, Inc.

Global Telecommunications Market Take, Forecast, July 2006a. United States: Gartner.

Global Telecommunications Market Take, Forecast, October 2006b. United States: Gartner.

Innala, Magnus & Bråténius, Anders 2005: Telecom Equipment, Information Technology Hardware, Mobile Operator Survey, Research Report, October 2005. Norway: ABG Sundal Collier.

Market Share, Global OSS Supplier Market Leadership in 19 Segments, February 2006. United States: OSS Observer.

Mobile Network Infrastructure Contracts, Worldwide, 2Q06, October 2006. United States: Gartner.

NEMs Operational Management Systems, InDepth, April 2005. United States: OSS Observer.

The New Frontier For Vendors, An Analysis of Network Services and Outsourcing, 2006. United States: Pyramid Research.

A new R&D Paradigm: Building OSS systems with standardized middleware, White Paper, 2004. Finland: Nokia.

Operations Support Systems 2000-2010, Worldwide, July 2006. United States: Gartner.

Operations Support Systems 2005-2010, April 2005. United States: The Insight Research Corporation.

OSS Market Perception Study, Heavy Reading, March 2005. United States: Light Reading, Inc.

World Cellular Investors, Quarterly Datasheet, March 2006, published in June 2006. United Kingdom: Informa Telecoms & Media.

World Telecommunication Indicators 2004/2005, November 2005. Switzerland: International Telecommunication Union. ISBN 92-61-11331-1.

Worldwide Broadband Services 2006-2010, Forecast, May 2006. United States: IDC.

Electrical References:

Amdocs Completes Acquisition of OSS Solutions Provider Cramer [homepage on the Internet]. Island of Guernsey: Cramer, Amdocs OSS Division; 2006 Aug 25 [cited 2007/01/13]. Available from: http://www.cramer.com/content.asp?Ref=1-2-1&NewsID=219

Aricent delivers innovative software solutions for the entire communications infrastructure [homepage on the Internet]. Palo Alto (CA, United States): c2007 [cited 2007/1/17]. Available from: http://www.aricent.com/products/equipment-manufacturers-products.html Note: Aricent is the former Flextronics Software Systems.

Bramson-Boudreau, Elizabeth according to 3G.co.uk. Ericsson and 3G Operator 3's Deal Only a Precursor [homepage on the Internet]. United Kingdom: 3G.co.uk; 2005 Dec 7 [cited 2007/1/8]. Available from: http://www.3g.co.uk/PR/Dec2005/2335.htm

Co-operative OSS Project [homepage on the Internet]. Morristown (NJ, United States): TeleManagement Forum; c2006 [cited 2006/12/19]. Available from: http://www.tmforum.com/browse.aspx?catID=2272

EMC to Acquire SMARTS [homepage on the Internet]. Hopkinton (MA, United States): EMC^2; 2004 Dec 21 [cited 2007/1/13]. Available from: http://www.emc.com/news/emc_releases/showRelease.jsp?id=2836&l=en&c=US

Ericsson and 3G Operator 3's Deal Only a Precursor [homepage on the Internet]. United Kingdom: 3G.co.uk; 2005 Dec 7 [cited 2007/1/8]. Available from: http://www.3g.co.uk/PR/Dec2005/2335.htm

Ericsson to acquire key assets of Marconi's telecommunications business [press release on the Internet]. Stockholm (Sweden): Ericsson; 2005 Oct 25 [cited 2007/1/9]. Available from: http://www.ericsson.com/ericsson/press/releases/old/20051025-080124.html

eTOM, The enhanced Telecom Operations Map® [homepage on the Internet]. Morristown (NJ, United States): TeleManagement Forum; c2006 [cited 2006/12/19]. Available from: http://www.tmforum.org/browse.aspx?catID=1647

The Free Software Definition [homepage on the Internet]. Boston (MA, United States): Free Software Foundation, GNU Project; [cited 2007/1/4]. Available from: http://wwww.gnu.org

Get Ready for Windows Vista [homepage on the Internet]. Redmond (WA, United States): Microsoft Corporation; c2006 [cited 2006/12/28]. Available from: http://www.microsoft.com/windowsvista/getready/default.mspx

Global Presence, Overseas Investments [homepage on the Internet]. Singapore (Singapore): SingTel; [cited 2006/9/19]. Available from: http://home.singtel.com/about_singtel/global_presence/overseas_investments/overseas_investments.asp

Google Scholar Beta [database on the Internet]. Mountain View (CA, United States): Google Corporation; [cited 2007/1/8]. Search: ‘author:"Yin" intitle:"Case Study Research: design and methods"’. Available from: http://scholar.google.com/scholar%3Fq%3Dauthor:%22Yin%22+intitle:%22Case+Study+Research:+design+and+methods%22+%26hl%3Dfi%26lr%3D%26oi%3Dscholarr

i-Mode Frequently Asked Questions[homepage on the Internet]. Tokyo (Japan): Eurotechnology Japan K. K.; c2004 [cited 2006/12/14]. Available from: http://eurotechnology.com/imode/faq-gen.html i-mode History [homepage on the Internet]. Tokyo (Japan): NTT DoCoMo, Inc; c2006 [cited 2006 Dec 14]. Available from: http://www.nttdocomo.com/services/imode/history/index.html

IBM to acquire Micromuse for $865 million [homepage on the Internet]. Chicago (IL, United States): Prism Business Media Inc, TELEPHONYonline; 2005 Dec 21 [cited 2007/1/13]. Available from: http://telephonyonline.com/finance/news/ibm_aquires_micromuse_122105/

IBM to Acquire Vallent [press release on the Internet]. New York (United States): IBM Corporation; 2006 Nov 28 [cited 2007/1/2007]. Available from: http://www-03.ibm.com/press/us/en/pressrelease/20682.wss

In-depth Wi-Fi Information [homepage on the Internet]. Austin (TX, United States): Wi-Fi Alliance; c2006 [cited 2006/12/19]. Available from: http://www.wi-fi.org/knowledge_center_overview.php

IONA Open Source Solutions [homepage on the Internet]. Dublin (Ireland): IONA Technologies; c2006 [cited 2006/12/15]. Available from: http://www.iona.com/solutions/opensource/?WT.mc_id=123463

Lucent, Alcatel Finalize Merger [homepage on the Internet]. Darien (CT, United States): Jupitermedia Corporation, Internetnews.com; 2006 Apr 3 [cited 2006/12/14]. Available from: http://www.internetnews.com/infra/article.php/3596001

Managing the Blue Ocean of Convergence [homepage on the Internet]. Morristown (NJ, United States): TeleManagement Forum, TeleManagement World Americas; c2006 [cited 20007/1/12]. Available from: http://www.tmforum.org/browse.aspx?catID=4010 Note: Introduction of the speech of Keith Willetts.

The Middleware [R]evolution [homepage on the Internet]. Redwood Shores (CA, United States): Oracle Corporation; [cited 2007/1/14]. Available from: http://www.oracle.com/products/middleware/docs/mw-revolution.pdf

Multiprotocol Label Switching [homepage on the Internet]. Sterling (VA, United States): The Internet Engineering Task Force; [last modified 2006/3/24; cited 2006/12/19]. Available from: http://www.ietf.org/html.charters/mpls-charter.html

Nokia and Siemens in network deal [homepage on the Internet]. London (United Kingdom): BBC, BBC News; [last modified 2006/6/19; cited 2006/12/14]. Available from: http://news.bbc.co.uk/1/hi/business/5093536.stm

Oracle Buys MetaSolv Software [press release on the Internet]. Redwood Shores (CA, United States): Oracle Corporation; 2006 Oct 23 [cited 2007/1/9]. Available from: http://www.oracle.com/corporate/press/2006_oct/oracle_metasolv.htm

Our Members [homepage on the Internet]. Morristown (NJ, United States): TeleManagement Forum; c2006 [cited 2006/9/11]. Available from: http://www.tmforum.org/browse.aspx?catid=737

Roberts, Paul F. HP to acquire Mercury for $4.5 billion [homepage on the Internet]. San Francisco (CA, United States): InfoWorld; 2006 Jul [cited 2007/1/13]. Available from: http://www.infoworld.com/article/06/07/26/HNhpmercury_1.html?APPLICATION%20MANAGEMENT

Scramble for licences [homepage on the Internet]. London (United Kingdom): BBC, BBC News, World Edition; 2001 Apr 12 [cited 2007/1/2]. Available from: http://news.bbc.co.uk/2/hi/business/1272501.stm

Skype. Koko maailma puhuu ilmaiseksi (free translation: “Skype. The whole world talks free of charge”) [homepage on the Internet]. Luxembourg (Luxembourg): Skype Limited, Skype Finland; c2006 [cited 2006/12/15]. Available from: http://www.skype.com/intl/fi/ (Fin) Note: for language according to your location try from: http://www.skype.com/

Telstra selects Alcatel for network transformation [homepage on the Internet]. Bristol (United Kingdom): fibers.org; 2005 Nov 11 [cited 2006/12/14]. Available from: http://fibers.org/articles/news/7/11/12/1

Vodafone picks Nokia to build 3G [homepage on the Internet]. Sydney (Australia): FairfaxDigital, The Age; 2004 May 11 [cited 2007/1/14]. Available from: http://www.theage.com.au/articles/2004/05/10/1084041311036.html?from=storyrhs

What is Free Software?, c1996 [cited 2007/1/4]. Available from: http://wwww.gnu.org

WiMAX Technology [homepage on the Internet]. Beaverton (OR, United States): WiMAX Forum; [cited 2006/12/19]. Available from: http://www.wimaxforum.org/technology

Windows XP Is Here! [press release on the Internet]. Redmond (WA, United States): Microsoft Corporation; 2001 Oct 25 [cited 2006/12/28]. Available from: http://www.microsoft.com/presspass/press/2001/oct01/10-25xpoverallpr.mspx

Substance Interviews:

Aho, Jaakko. Director, OS Business Development, Nokia and Member of the TM Forum’s Board of Directors. Interviewed at Tampere, Finland September 12, 2006a.

Custeau, Randy. Director, Marketing and Strategy, Agilent Technologies. Interviewed over-the-phone in Canada 21.11.2006, 1h40.

D’Hauwers, Guy. Director, Business Development, EMEA, Hewlett-Packard. Interviewed in Copenhagen, Denmark 15.11.2006, 2h10.

Koenig, Kevin. Former Vice President and Business Unit head of Sasken. Interviewed over-the-phone in New York, United States 6.11.2006, 2h20.

Leinonen, Anu H. System Specification Specialist, Nokia. Interviewed at Tampere, Finland about IMS role in convergence 13.12.2006.

Pasonen, Kari. Vice President, Provisioning Business, Comptel. Interviewed in Helsinki 16.11.2006, 1h.

Pesonen, Markku. Head of Network Element Usage and Maintenance, Elisa. Interviewed in Helsinki, Finland 3.11.2006, 2h10.

Polpoudenko, Dmitry I. Head of network integration and optimization, O&M Department, North-West branch of OJSC “MegaFon”. Interviewed in St. Petersburg, Russia 18.12.2006, 2h05.

Schmidbauer, Alfred. Vice President, OSS Portfolio Management, Siemens. Interviewed in Espoo, Finland 14.11.2006, 1h40.

Vorbrig, Ralf. Senior Manager, OSS Strategy and Design, Vodafone Group. Interviewed in Düsseldorf 23.11.2006, 1h50.

Willetts, Keith. Chairman of TeleManagement Forum. Interviewed in Baylham, Ipswich, United Kingdom, 29.11.2006, 2h40.

Interviews to identify interview objects (Appendix 2):

Aho, Jaakko. Director, OS Business Development, Nokia and Member of the TM Forum’s Board of Directors. Interviewed over the phone in October 2006b.

Carobene, Mauro. SW Head of Sales, Nokia. Interviewed over the phone in October 2006.

Eskola, Jari. Director, Global Sales Development, Nokia. Interviewed at Tampere, Finland in October 2006.

Haapakoski, Markku. Director, Convergence Business Team, Nokia. Interviewed over the phone in October 2006.

Kivilinna, Hannu. Head of Partnering, Nokia. Interviewed over the phone in October 2006.

Koponen, Juho. Head of SW Sales, Nokia. Interviewed over the phone in October 2006.

Loukola, Kari. General Manager, OS Middleware Business Line, Nokia. Interviewed over the phone in October 2006.

Repo, Pekka. Director of Technology, Nokia. Interviewed over the phone in October 2006.

Seppälä, Juho J. Director, OS Product and Portfolio Management, Nokia. Interviewed at Tampere, Finland in October 2006.

Sundström, Pekka. Senior Product Manager, Nokia. Interviewed over the phone in October 2006.

Taka, Ville. Vice President and General Manager, Hewlett-Packard. Interviewed at Tampere, Finland in October 2006.

8 TERMS AND ABBREVIATIONS

CAGR	Cumulative Annual Growth
CORBA	Common Object Request Broker Architecture
CSP	Communication Service Provider (Section 3.4.2)
DSL	Digital Subscriber Line
EIR	Equipment Identity Register
ETSI	The European Telecommunications Standards Institute
eTOM	enhanced Telecom Operations Map® of the TM Forum
GSM	Global System for Mobile Communications
HSDPA	High Speed Downlink Packet Access
IMS	IP Multimedia Subsystem
IO	Industry Organization (Section 3.4.2)
IOV	Independent OSS Vendor (Section 3.4.2)
ITU	The International Telecommunication Union
ITU-T	The Telecommunication Standardization Sector of ITU
ITV	IT System Vendor (Section 3.4.2)
KPI	Key Performance Indicator
MPLS	Multiprotocol Label Switching
MSW	Major Software Company (Section 3.4.2)
MVNO	Mobile Virtual Network Operator
NEP	Network Equipment Provider
NGOSS	New Generation Operations Systems and Software
NMS	Network Management System
OMC	Operations and Maintenance Centre
ORB	Object Request Broker
OSS	Operations Support System
OSS/J	Operations Support System through Java
SI	Systems Integrator (Section 3.4.2)
SLA	Service Level Agreement
SOA	Service Oriented Architecture
SWS	Software Subcontractor (Section 3.4.2)
TM Forum	TeleManagement Forum
TMN	Telecommunication Management Network
USB	Universal Serial Bus
Wi-Fi	Wireless Fidelity: WLAN network for public Internet access
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
xDSL	any variant of Digital Subscriber Line

APPENDICES

Appendix 1: Entities managed by TMN

The International Telecommunication Union has defined (ITU-T Recommendation M.3010, 2000, 6-8) a quite comprehensive list of entities that can be managed i.e. planned, provisioned, installed, maintained, operated and administered by a TMN:

1. Public and private networks, including both narrow and broadband ISDNs (including ATM), mobile networks, private voice networks, virtual private networks and intelligent networks;
2. TMN itself;
3. Transmission terminals (multiplexers, cross-connects, channel translation equipment, SDH, etc.);
4. Digital and analogue transmission systems (cable, fibre, radio, satellite, etc.);
5. Restoration systems;
6. Operations systems and their peripherals;
7. Mainframes, front-end processors, cluster controllers, file servers, etc.;
8. Digital and analogue exchanges;
9. Area networks (WAN, MAN, LAN);
10. Circuit and packet switched networks;
11. Signalling terminals and systems including signal transfer points (STP) and real-time databases;
12. Bearer services and teleservices;
13. PBXs, PBX accesses and user (customer) terminals;
14. ISDN user terminals;
15. Software provided by or associated with telecommunications services, e.g. switching software, directories, message databases, etc.;
16. TMN software applications;
17. Associated support systems (test modules, power systems, air conditioning units, building alarm systems, etc.).
18. Distributed entities and services offered by grouping of the items in the above list;
19. Resources related to the processes that a PTO uses in the operation of equipment, networks and services. Examples of such managed resources are equipment repair service order, trouble tickets generated by customer complaints, customer contract for service provisioning, service level agreements, historical data, etc.

Appendix 2: The Process to Identify and Engage Interviewees

This appendix describes why and how the persons who were interviewed during the empirical phase of the study were identified and engaged to ensure that they represent the OSS industry in a balanced way.

First, TM Forum Board Member Jaakko Aho (2006b) was interviewed in order to verify the feasibility of the developed industry structure model (Section 3.4) and to list companies that would well represent the targeted interview objects. After this the personal network of the investigator was used to identify a suitable interviewee candidate within each interview object and to get permission from the candidate for an in-depth interview.

Mauro Carobene (2006), who is responsible for Nokia´s OSS relationship with Vodafone Group, was contacted and asked whether he has a good relationship with the person inside the Vodafone Group who is responsible for OSS, and if this person has a deep enough industry experience in order to participate in the study. Carobene said that he has a very good relationship with Ralf Vorbrig and definitely recommends him as a person with an excellent industry view. After this Carobene called Vorbrig, explained what this study is all about and asked for his support and participation. Only after the permission was received, the investigator sent the invitation letter (Appendix 3) and contacted Vorbrig in order to agree on a date.

The same procedure was repeated for the other interview candidates. The invitation letter was emailed but otherwise phone or face-to-face discussions were used as much as possible to identify candidates and persuade them to participate. In short:

- Juho J. Seppälä (2006) and Juho Koponen (2006) were contacted in order to identify and ask Dmitry Polpoudenko of MegaFon to participate.
- Markku J. J. Haapakoski (2006) was contacted in order to identify and ask Markku Pesonen of Elisa to participate.
- Pekka Repo (2006) was contacted in order to identify and ask Alfred Schmidbauer of Siemens to participate.
- Ville Taka (2006) was contacted in order to identify and ask Guy D´Hauwers of HP to participate.
- Hannu Kivilinna (2006) was contacted in order to identify and ask Kevin Koenig, a former Sasken and Lucent employee, to participate.

- Randy Custeau of Agilent was contacted directly as a suitable candidate, without any personal ties, based on his role as Advisory Director in the TM Forum.
- Jari Eskola (2006) and Pekka Sundström (2006) were contacted in order to identify and ask Kari Pasonen of Comptel to participate the study.
- The chairman and founder of TM Forum, Keith Willetts was contacted directly as a person who, if anyhow possible, had to be interviewed for a study of this scope (Kari Loukola 2006).

Special attention was paid to identify interview candidates who have long industry experience and are appreciated for their wide view and future-oriented thinking even outside of their own organizations. Their formal current position was regarded as less important, although due to the listed qualities the interviewees hold key professional positions.

No interview candidate refused an interview when it was proposed by a person who had a personal relationship with him. In this sense the coverage of the targeted interviewees was 100%. However, three interview candidates who were not yet personally contacted by an acquaintance, but already considered as candidates were lost due to a change of employer, a change of position and a merger. As these events were unrelated to the study, and at least other similarly qualified interviewee candidates were successfully identified, this factor can be assumed not to have impacted the results.

Appendix 3: Invitation Letter

A personally tailored version of this invitation letter was delivered to each interview candidate supported by someone with a personal relationship to the interviewee.

Tampere, Finland
October 12, 2006

Dear Mr. Guy D´Hauwers,
Hewlett-Packard

What would a radical disruption in the OSS industry mean to You? Is the OSS industry likely to continue steadily or heading towards a major turmoil?

Earlier the forecasting of industry disruptions has been seldom successful, but lately the theories have developed tremendously. This is a study where after complementing and adapting the general theories of industry disruption to the OSS industry, it is now time to have selected interviews and compare the developed model to the real world. Naturally, we can see the results only after the interviews, but in this late phase of the desktop research the outlook is very tempting.

I have used my industry contacts gathered during the past one and half decades in order to select about ten interview candidates, including You, who would together have an extraordinary, many-sided view on the industry. This is not a sampling study, but each one of You would be representing a different point of view and for a solid industry picture, meeting every one would be important. In order to achieve this, I am very flexible to adjust my travel to Your plans. The overall target is to conduct all the interviews during November 2006.

I used to lead as General Manager the Nokia product line responsible for NetAct™ , the Nokia OSS solution, but at the moment I am on a study leave in order to conduct this research for the University of Tampere. Professor Hannu Kuusela, Department of Management Studies is directing the work. If successful, this study will lead to my second university degree.

The study is targeted to end early 2007. After that, the essential parts of the study report will be confidential 2-3 years depending on the sensitivity of the gathered material. However, an executive summary combining the major findings will be distributed to all interviewees at the termination of the study.

A reservation of 1.5 hours for the interview would be appreciated, even if all of that will not be necessarily needed. I really hope that a time slot for the interview could be found and we will have the opportunity to discuss the likely development of this inspiring industry.

Best Regards,

Timo-Pekka Leinonen
+358 40 506 6048
timo-pekka.leinonen@kolumbus.fi

Appendix 4: Theme Interview Questionnaire

Version 1.1: Network Management Outsourcing questions added 06.11.2006.

1. Introductions (interviewer leading)

    a. Timo-Pekka
        i. Responsible for Nokia NetAct™, Nokia´s OSS solution until mid 2006.
        ii. Now on a study leave in order to conduct this interesting research leading also to second university degree at the University of Tampere.
    b. Interviewee
        i. Exact position and title. Get a business card, if possible.
    c. Interview details
        i. Date and time
        ii. Duration
        iii. Location

2. Motivation: purpose of the research (interviewer leading)

    a. General theories to forecast industry disruptions developed tremendously during the past years. Now time to try for our OSS industry.
    b. Study results confidential 2-3 years depending on the sensitivity of the gathered material. However, an executive summary combining the major findings will be distributed to all interviewees at the termination of the study, early 2007.

3. Definition of the key concepts (interviewer leading, separate slides)

4. Structure of the interview (interviewer leading)

    a. First there will be some open-ended questions in order to understand how you see the OSS industry. These will be followed with more close-ended questions in order to evaluate the theoretical model. In the end we will spend some time in order to try to estimate the probability and strength of the identified disruptive and stabilizing forces.

b. There are no correct answers. Important is what you as one of the key decision maker / expert in the industry think. Therefore, it is OK and even recommendable to answers based on your initial feeling.

5. General questions (interviewee leading): to here by 15 min past

   The purpose of these questions is to find out how the interviewee sees the industry without links to the theoretical model.

   a. What do you regards generally as the major changes in the communications during the past three years (2004-2006)?
   b. What do you see as the major changes that have taken place in the OSS industry during those years?
   c. What do you anticipate as the next major changes in the communications (2007-2009)?
      i. Generally?
      ii. On your own area?
   d. How do you think that those changes will impact OSS?
   e. What are your / what do you think that are the CSPs major strategic requirements for the OSS systems?
      i. Generally?
      ii. On your own area?
   f. What are the (other) major business forces (drivers) of the OSS industry?
   g. What is the structure of the OSS industry (the interviewee to draw a simple picture, if possible)?
   h. What do you see as the major forces disrupting the OSS industry?
      i. Generally?
      ii. On your own area?
      iii. Any other?
   i. What do you see as the major forces stabilizing the OSS industry?
      i. Generally?
      ii. On your own area?

iii. Any other?

j. Summarize once more the identified forces. Any other?
k. Who are the leaders of the OSS industry?
l. If leaders identified, ask why are these companies the leaders? (What characteristics make them leaders?)
m. If no leaders identified, ask
   i. What kind of a company could take the leadership? (What are the required key characteristics)?
   ii. Could any of the existing companies become the leader?
   iii. What would be the required steps?
n. Does NN as the OSS industry leader / the missing leadership drive the industry towards change or keep it stable?
o. Regulation
   i. How do You see the regulation of the OSS industry?
   ii. Would You categorize it as weak or strong?
   iii. Does the current OSS industry regulation accelerate or slow down the industry development?

6. Theory-based questions (interviewee leading): to here by 45 min past

The purpose of these questions is to confirm or reject the disruptive and stabilizing forces found during the desk top research. Go through only those forces that have not been covered during the previous section.

a. Do the OSS systems contain unnecessary or unused software functionality? How much?
b. Do CSPs have recurring costs like maintenance, integration, or training for this unused functionality? Are the costs significant?
c. Do you/CSPs have operations that could be made more efficient with OSS type of software?
d. What is the main reason for not using OSS type software to solve these issues (cost, functionality, something else)?
e. According to Gartner (show statistics), the external OSS market 2006 is 4.0 billion euros and the related integration cost 12.9 billion. Are these costs in balance?

f. Is the *Integration Cost* a disruptive force in the OSS industry?

g. Do you think that the integration of the OSS systems is an especially profitable business for the system integrators?

h. Are the *SI Revenues* a stabilizing force in the OSS industry?

i. Currently each NEP develops separately a telecom specific middleware software layer that is necessary but does not yet provide differentiation. Do you think that the NEPs could use more similar or even the same middleware software in their OSS systems?

j. Do you think that a disruption towards common middleware software will take place?

k. Does it change the industry i.e. is it a disruptive force?

l. Is the following claim correct? Typically, the value of the OSS systems is close to 10% of the value of the overall infrastructure. However, if the OSS system does not work the whole communications network will experience serious technical problems. This *High Failure Penalty* makes the CSPs very sensitive for any radical OSS changes.

m. Is the *High Failure Penalty* a force stabilizing the OSS industry development?

n. Similarly, is the following claim correct? As the value of the OSS systems is only close to 10% of the value of the overall infrastructure, it makes the buyers to focus on other parts of the system and thus reduces the change pressure on OSS.

o. Is the low proportional *Cost as Part of Infrastructure* a force stabilizing the OSS industry development?

p. How would You estimate the profitability of the OSS business for NEPs compared to the profitability of their overall business?

q. Does this profitability for NEPs impact the OSS industry development (accelerate or stabilize)?

r. Is the communications industry moving towards a mature state?

s. How does this impact the development of the OSS industry (accelerate or stabilize)?

t. Fixed-mobile convergence is seen as one of the coming major changes in the communications. Is it going to take place and does it essentially change the communications?

u. Does the fixed-mobile convergence impact the development of the OSS industry (accelerate or stabilize)?
v. It seems that new communication technologies are emerging all the time. Is this true from a single operator point of view?
w. If yes, how do the *New Communication Technologies* impact the development of the OSS industry (accelerate or stabilize)?
x. Several operators have outsourced their network management operations to NEPs, for example 3 in UK to LME. And several NEPs have announced their operating services. Do you think that this trend is going to continue?
y. If yes, how does the *Network Management Outsourcing* impact the development of the OSS industry (accelerate or stabilize)?
z. The *Replacement Costs* of an OSS system do not limit to the value of the system itself but include also elements like the integration, training and possible process change costs and a replacement period with lower efficiency. Are the *Replacement Costs* a stabilizing force in the OSS industry?

7. Probability and strength estimation for each identified new force and for the confirmed forces of the theoretical model (interviewee leading): to here by 70 min past

   Estimate roughly the probability and strength of the identified forces using the separate fill-in template. This is the section to drop out, if the interview time is running short.

8. Closure (interviewer leading): to here by 85 min past

   a. Is there something essential related to the OSS domain that we have not yet covered?
   b. Thank You: Thank you a lot for your time, and interesting views about the OSS industry
   c. Permission for clarification questions: If it will later occur that I would like to still clarify something related to this study and interview, is it OK to contact you by email or over the phone?

d. The estimated level of granularity of the study report will be the probability and strength estimations of the forces and some of the key reasoning. What kind of confidentiality need do You have for the study report: none, two or three years?

e. Executive summary early 2007.

Definition: OSS

- Operations Support System: Systems that Communication Service Providers (CSPs) use or could use in order to operate efficiently.
- Wide definition not limited to the existing systems.

Definition: Disruption

- Rapid, fundamental change in the industry. Eg.
  - Photography: analog -> digital
  - PCindustry, Dell: very low deliver channel
  - PCindustry, Intel: architecture leadership
- Changes the rules of the game
  - Impacts (almost) all companies
  - Doing the same somewhat better does not help
  - Success: new entrants and old players, who totally reinvent themselves
- Opposite to *disruptive forces* are *stabilizing forces*.
- Simultaneous disruptions are possible.

Figure 21 Slide for Definition of Key Concepts (Part 3)

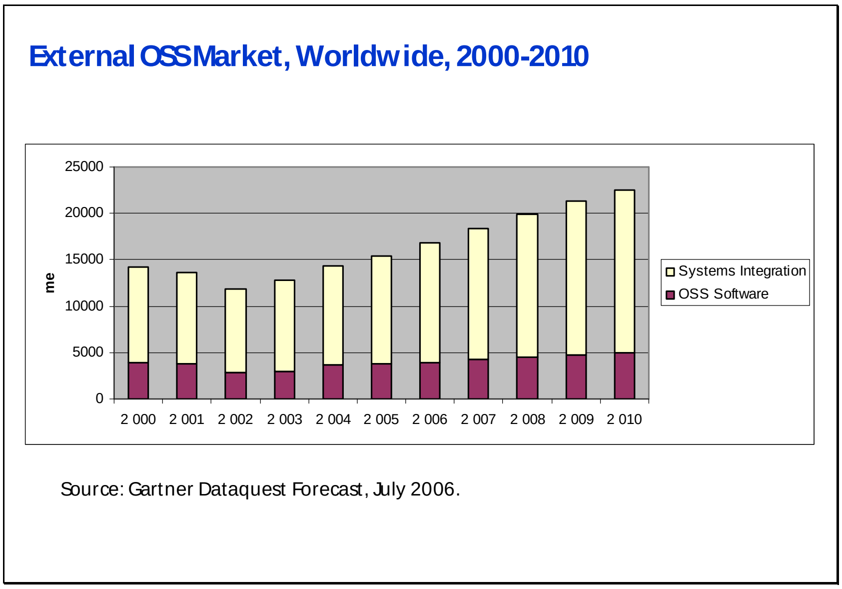

Figure 22 Slide for Depicting Integration Cost (Question 6. e)

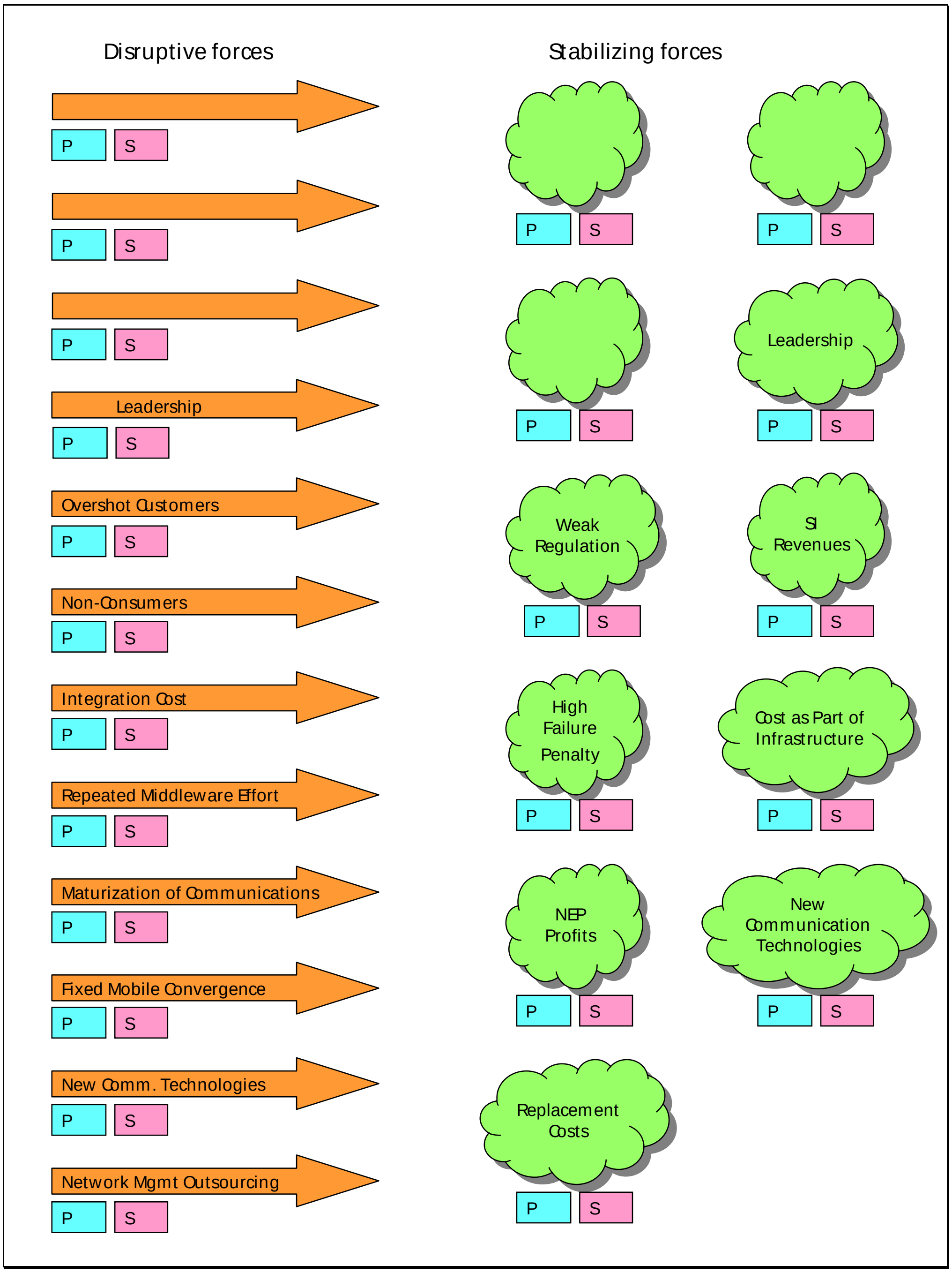

Figure 23 Template for Probability and Strength Estimation (Part 7)

Version 1.0, printed in A3 size.

Probability

1 Unlikely	Probability 1-33%
2 Fifty-fifty	Probability 34-66%
3 Likely	Probability 67-99%
4 Definite	Probability 100%

Is there something that would significantly increase or decrease the probability?

Strength

1 Minor	Has impact, but will not change or maintain the industry structure.
2 Medium	Has impact, and can with other forces change or maintain the industry structure.
3 Major	Will alone change or maintain the industry structure.

Is there something that would significantly increase or decrease the strength?

Figure 24 Legend for Probability and Strength Estimation (Part 7)