HELSINKI UNIVERSITY OF TECHNOLOGY
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Scenarios and Operator Business Models for Management of Digital Homes

Master's thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Technology

Espoo, March 8, 2007

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HELSINKI UNIVERSITY OF TECHNOLOGY Abstract of the Master's Thesis

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The digital home is a new concept that has spread rapidly while consumers have been upgrading their electronic devices into the digital age. The increasing number of network-enabled devices, and connecting them with each other and to the Internet are the key characteristics of digital homes. This thesis attacks the problem that arises from the increasing complexity of managing the digital home systems.

Management help offered by service providers to home users is assumed to play an important role in the future of digital home service business. With the help of ideas and information gathered from expert interviews and various written sources, four management scenarios were developed in this thesis. The scenarios provide insight into possible directions for future development, and explain the role of management provision in relation to the other domains of digital service business. The scenarios are constructed from the operator point-of-view.

This thesis also presents examples of operator business models that together with the scenarios show that effective service aggregation will be an important success factor. The consumers will not be willing to pay for management as such; the cost of management should be hidden within a service bundle.

Keywords:	digital home, home network, scenario, business model, management hierarchy

TEKNILLINEN KORKEAKOULU **Diplomityön tiivistelmä**

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Työn nimi:	Digitaalisten kotien hallintaskenaariot ja operaattorien liiketoimintamallit digitaalisten kotien hallinnassa		
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Työn ohjaaja:	Mathias Tallberg, DI		

Digitaalisen kodin käsite on levinnyt nopeasti kuluttajien päivittäessä kotien laitteistoja digitaaliselle aikakaudelle. Digitaalisen kodin tunnusmerkkejä ovat kasvava verkkokykyisten laitteiden määrä ja niiden liittäminen sekä toisiinsa että Internetiin. Digitaaliset kodit muuttuvat koko ajan monimutkaisemmiksi ja niiden hallinta yhä haastavammaksi. Tämä työ pureutuu syntyvään hallintaongelmaan.

Oletuksena on, että yritysten tarjoamat digitaalisten kotien hallintapalvelut ovat tulevaisuudessa keskeisessä asemassa kotikäyttäjiin suuntautuvassa palveluliiketoiminnassa. Tämä tutkimus esittelee neljä hallintaskenaariota, jotka kehitettiin asiantuntijahaastatteluista ja kirjallisuuslähteistä kerättyjen ideoiden ja tiedon avulla. Skenaariot tarjoavat näkemyksiä mahdollisista tulevaisuuden kehityssuunnista, ja selittävät hallintapalveluiden asemaa muuhun palveluliiketoimintaan nähden. Skenaariot on rakennettu tarkastellen toimialaa operaattorin näkökulmasta käsin.

Esimerkit operaattorien liiketoimintamalleista ovat olennainen osa tämä tutkimusta. Ne yhdessä skenaarioiden kanssa osoittavat, että eri palveluiden yhdistäminen kokonaisuuksiksi (kytkykauppa) tulee olemaan tärkeä menestyksen aines. Kuluttajat eivät ole valmiita maksamaan digitaalisen kodin hallinnasta yksinään, vaan hallintapalveluiden kustannukset tulee peittää suurempien palvelukokonaisuuksien sisälle.

Avainsanat: digitaalinen koti, kotiverkko, skenaario, liiketoimintamalli, hallintahierarkia

Preface

This Master's Thesis completes my studies for the Master of Science degree in Helsinki University of Technology. The work has been carried out between May 2006 and March 2007 at the Networking Laboratory at the Department of Electrical and Communications Engineering. This thesis is a deliverable for the Tekes project InHoNets (Interconnected Broadband Home Networks).

I would like to thank my supervisor, Professor Heikki Hämmäinen, for giving me the opportunity to write the thesis at the Networking Laboratory, and for guiding me during the course of my work.

I wish to express my gratitude to my instructor Mathias Tallberg, who has given me valuable advice during the writing process. I also thank my other co-workers in the Networking Business team, and the InHoNets project partners and fellow researchers. I am especially thankful to the interviewees for their comments and opinions.

Finally, I wish to thank my family and my friends for being supportive throughout my studies.

Espoo, March 8, 2007

Timo Nordlund

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Abbreviations

3G	*Third Generation Mobile Technology*
A/V	*Audio/Video*
ADSL	*Asymmetric Digital Subscriber Line*
ASP	*Application Service Provider*
bps	*Bits Per Second*
CAGR	*Compound Annual Growth Rate*
CATV	*Cable Television*
CD	*Compact Disc*
CE	*Consumer Electronics*
CPE	*Customer Premises Equipment*
DLNA	*Digital Living Network Alliance*
DOCSIS	*Data Over Cable Service Interface Specifications*
DSL	*Digital Subscriber Line*
DRM	*Digital Rights Management*
DVB	*Digital Video Broadcasting*
DVB-C	*Digital Video Broadcasting – Cable*
DVB-H	*Digital Video Broadcasting – Handheld*
DVB-S	*Digital Video Broadcasting – Satellite*
DVB-T	*Digital Video Broadcasting – Terrestrial*
DVD	*Digital Versatile Disc*
DVR	*Digital Video Recorder*
eTOM	*enhanced Telecom Operations Map*
ETSI	*European Telecommunications Standards Institute*
FAQ	*Frequently Asked Questions*
FCAPS	*Fault, Control, Accounting, Performance, Security*
Flash-OFDM	*Fast Low-latency Access with Seamless Handoff Orthogonal Frequency-Division Multiplexing*
FTTB	*Fiber-to-the-Building*
FTTC	*Fiber-to-the-Curb*
FTTH	*Fiber-to-the-Home*
FTTP	*Fiber-to-the-Premises*

FTTX	*Fiber-to-the-x. E.g. FTTH = Fiber-to-the-Home.*
Gbps	*Gigabits Per Second*
GPRS	*General Packet Radio Service*
GSM	*Global System for Mobile Communications*
Hi-fi	*High-Fidelity*
HSDPA	*High Speed Downlink Packet Access*
HSPA	*High Speed Packet Access*
HSUPA	*High Speed Uplink Packet Access*
HVAC	*Heating, Ventilating, and Air Conditioning*
IEEE	*Institute of Electrical and Electronics Engineers*
IMAP4	*Internet Message Access Protocol version 4*
IP	*Internet Protocol*
IPTV	*Internet Protocol Television*
ISO	*International Organization for Standardization*
ISP	*Internet Service Provider*
IT	*Information Technology*
ITIL	*Information Technology Infrastructure Library*
kbps	*Kilobits Per Second*
LAN	*Local Area Network*
LCD TV	*Liquid Crystal Display Television*
LLU	*Local Loop Unbundling*
Malware	*Malicious Software*
MAN	*Metropolitan Area Network*
Mbps	*Megabits Per Second*
MP3	*MPEG-1 Audio Layer 3*
NAT	*Network Address Translation*
NIC	*Newly Industrialized Country*
OS	*Operating System*
OSI	*Open Systems Interconnection*
P2P	*Peer-to-Peer*
PAN	*Personal Area Network*
PC	*Personal Computer*

PDA	*Personal Digital Assistant*
PLC	*Power Line Communications*
PnP	*Plug-and-Play*
POP3	*Post Office Protocol version 3*
PSTN	*Public Switched Telephone Network*
PVR	*Personal Video Recorder*
QoS	*Quality-of-Service*
RGW	*Residential Gateway*
SIG	*Special Interest Group*
SIM	*Subscriber Identity Module*
SP	*Service Provider*
UI	*User Interface*
USB	*Universal Serial Bus*
VCR	*Video Cassette Recorder*
VDSL	*Very high data rate Digital Subscriber Line*
VoIP	*Voice over Internet Protocol*
WAN	*Wide Area Network*
WAP	*Wireless Application Protocol*
WCDMA	*Wideband Code Division Multiple Access*
Wi-Fi	*Wireless Fidelity*
WiMAX	*Worldwide Interoperability for Microwave Access*
WLAN	*Wireless Local Area Network*
WWW	*World Wide Web*
xDSL	*Digital Subscriber Line*

1. Introduction

1.1. MOTIVATION

The emergence of digital homes brings opportunities for hardware vendors, software firms and various kinds of service providers. New device categories emerge and home users update their old device configurations into the digital age. Typical digital home devices include computers, MP3 players, digital cameras, and home entertainment systems that are able to connect to the Internet and to each other through a home network.

The development directly broadens the revenue streams of vendors who offer consumer electronics, personal computing, and networking devices. It affects the business of software application developers, content providers, and network capacity providers. As the number of devices at homes increases, more and more software applications and content are needed to complement the devices, and the bandwidth requirements of Internet connections keep on growing. The digital environment as a whole with the devices connected to each other creates an attractive platform for service providers to experiment with new business models.

It is still open what the most valuable services around digital homes will be, what kinds of business models will be effective, and how the existing players are going to position themselves. This uncertainty makes it difficult to understand the situation in its entirety, but at the same time, it acts as an inspiring element for this study.

1.2. BACKGROUND

The popularity of home networks has been steadily growing for several years now. This is partly a result from the increasing number of computers per household, but the true spark has been the success of wireless technologies such as the IEEE 802.11 wireless local area network (WLAN) standard family and Bluetooth. The convenience of intra-home mobility and becoming detached from wired networks have improved home networking user experience.

Typical use cases have been interconnecting computers and peripherals, and sharing the Internet connection between multiple computers. However, the number of networked

devices is growing constantly, not only in personal computing domain, but also in mobile handsets and consumer electronics. At the same time, Internet connection speeds are increasing and new media interfaces are emerging. This overall development results in new application areas favoring the end users. However, the drawback is that the digital home environment becomes more complex and laborious to manage.

Home networking business cannot be considered as a bordered entity. It is more reasonable to view the digital service business as a whole and study how home networking will change it. An Insight Research study forecasts that the worldwide IP service market will grow from $11.6 billion in 2006 to approximately $94.8 billion in 2011.[1] Although these estimates should be considered critically, they describe well how attractive the market is to service providers.

As managing digital homes becomes ever more burdensome, the demand for management services is expected to grow. This study assumes that management service business has a special importance, because it affects all the other business areas related to home networking. If home users would have to cope by themselves with configuring, updating, and securing the home system, the market would grow slowly. Only technologically capable consumers would be able to set up fully working systems.

1.3. RESEARCH PROBLEM

Home networks potentially enable the provision of new services and create alternative ways to provide existing services. They also have an effect on the consumption of digital services and content. This study envisions the business implications that home networks have on the digital service industry by digging into *management of digital homes*.[2] The research problem is stated as follows:

What business opportunities does management of digital homes offer for operators?

To make the problem more convenient to handle, it is divided into the following sub-questions:

[1] Insight Research Corporation (2006). The revenues include the following services: residential telephony, fixed-mobile convergence, file sharing/downloading, audio/video streaming, location-based services and presence-based services.

[2] Since *management of digital homes* is a cumbersome expression in certain sentence structures, also the expression *digital home management* is used throughout this thesis.

What possible future scenarios are there for management of digital homes?

What will the operator role be in relation to other service providers?

How should today's operators prepare for the future?

What kinds of business models will be possible for management of digital homes?

1.4. SCOPE

This thesis takes a rather PC centric view on digital homes, and therefore it does not address to homes that are for example built around advanced set-top boxes developed by the consumer electronics industry.

Home networking presumably has a significant impact on the digital service business, which is the reason for this study to focus on services. Hardware sales is not out of scope though, since devices can be provided as a service, i.e. by leasing. Sales of hardware is undoubtedly a massive business by volume, and digitalization of homes involves updating old devices into new ones that comply with the digital rules. This thesis starts by giving an overview of technologies, devices, and services related to home networking, or digital homes, and then narrows the focus into management services, i.e. services that help home users to set up their systems and keep them safely up and running.

The scenarios and business models are developed from an operator point-of-view. The example operators used in the thesis are Finnish telecom or cable operators.

1.5. METHODS

The research methods adopted in this research are:

- Literature survey
- Expert interviews
- Analysis based on theoretical frameworks

The approach taken is mainly qualitative, even though some quantitative data is used for example to describe the market penetration of devices. Written sources include academic journals, management books, studies, and white papers. The interviews were done with Finnish telecom or IT firms and official authorities. The results from the interviews have

had a broad influence on this thesis; particularly they are utilized in the scenario construction.

The frameworks that were utilized in the analysis include:

- Business model
- Network services uncertainty theory
- Value chains
- Five competitive forces
- Value nets
- Industry scenarios

They are explained briefly in chapter 2.

1.6. STRUCTURE OF THE THESIS

The organization of this thesis is illustrated in Figure 1.

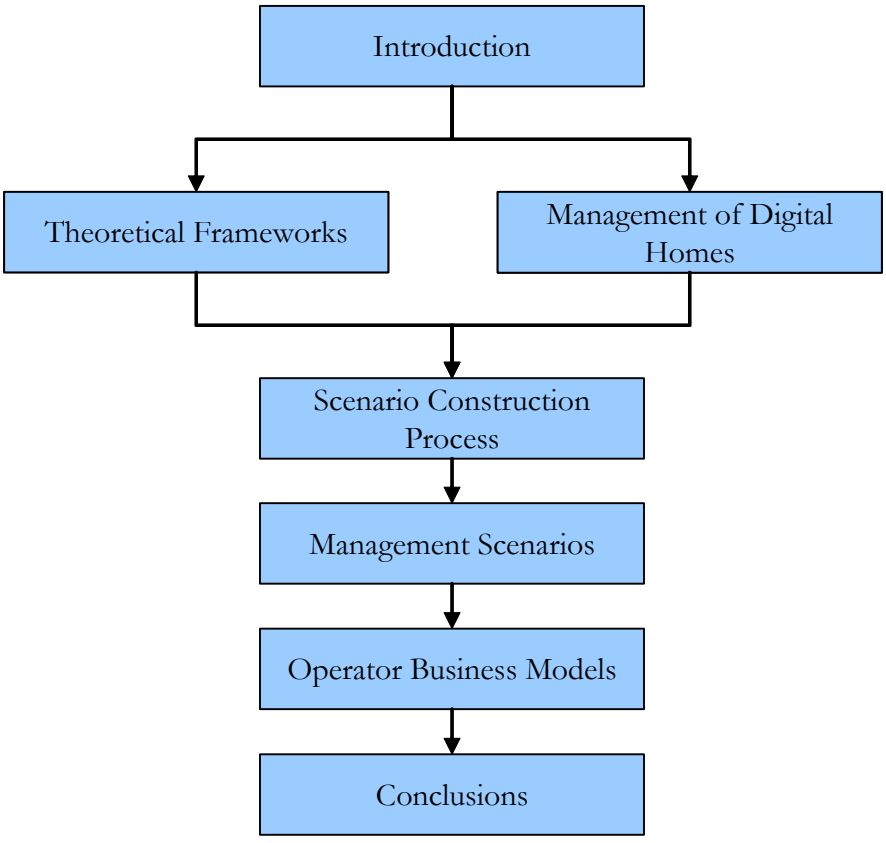

Figure 1. Structure of the Thesis

The introduction chapter provides an overview of the topic, and explains the research problem and the scope of the thesis.

The second chapter briefly describes the theoretical frameworks utilized in this thesis.

The third chapter gives an overview of the concepts of digital homes and management of digital homes. It presents some solutions currently available, describes the relevant technologies, and explains the management hierarchy of digital homes. Finally, the chapter lists the central assumptions that narrow down the scope of the rest of the thesis.

Chapter four explains the process of constructing the management scenarios; chapter five describes the resulting operator-centric scenarios.

The sixth chapter describes examples of business models related to management of digital homes and discusses operator strategies.

In chapter seven, the results of the thesis are presented, their importance is assessed, and suggestions for further research are given.

2. Theoretical Frameworks

This chapter explains the essential theoretical frameworks and concepts that are used in this thesis, and explains how they relate to each other.

2.1. BUSINESS MODEL

The term *business model* is commonly used in the media, academic journals, and business literature. Its exact meaning is though often unclear, because particularly in non-academic publications the authors fail to define it properly. It is therefore essential to describe comprehensively how the term is understood in this thesis.

In a very basic sense, a business model is the way by which a company makes money. However, this loose definition does not make difference for example between a business model and a revenue model. A revenue model describes the revenue streams that flow into the company, but this is actually just one element of the business model definition used here.

Several business model definitions can be found in the academic literature.[3] This study adheres to the definition developed by Chesbrough and Rosenbloom.[4] Since their definition is explicit, easy to comprehend and suits well in technological environments, it is logical to apply this view into home networks. Furthermore, the researchers in the ECOSYS project concluded that the framework is an applicable tool in telecommunications.[5] The logic of Chesbrough and Rosenbloom's definition is depicted in Figure 2.

Chesbrough and Rosenbloom propose that a business model consists of six functions that are to:

- Articulate the *value proposition*, i.e. what is offered, how it is offered, and what makes the transaction possible.[6]

[3] See e.g. Osterwalder (2004), Gordijn (2002), Alt & Zimmermann (2001) and Bouwman & MacInnes (2006)

[4] Chesbrough & Rosenbloom (2002)

[5] ECOSYS (2004). ECOSYS is a EUREKA/CELTIC project on techno-economics of mobile and fixed networks and services. ECOSYS' Web page: http://optcomm.di.uoa.gr/ecosys/ (Accessed February 12, 2007).

[6] Rayport & Sviokla (1994)

- Identify the *market segment* and specify the revenue generation mechanisms.
- Define the internal *value chain* required to create and distribute the offering.
- Estimate the *cost structure* and *the profit potential* based on the value proposition and value chain chosen.
- Position within the *value network*.
- Formulate the *competitive strategy* to gain sustainable advantage over rivals.

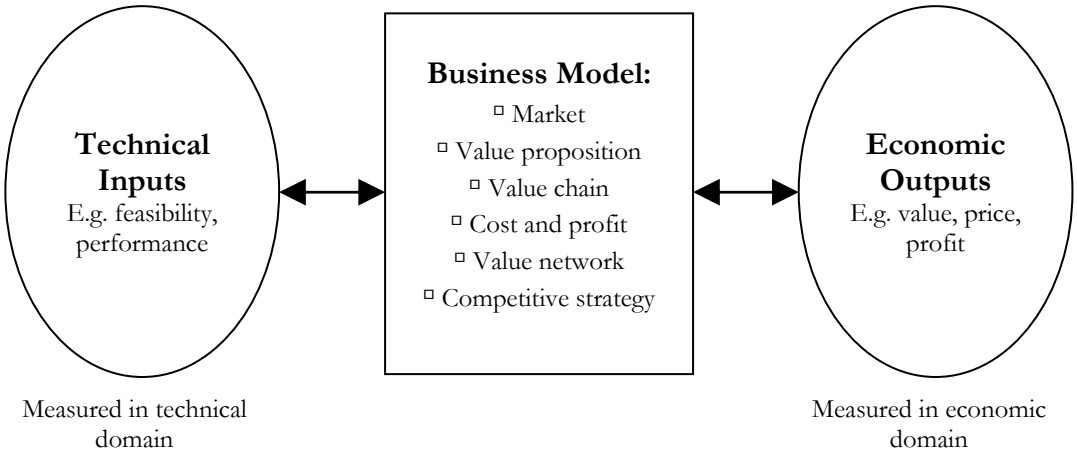

Figure 2. The Business Model Connecting Technical and Economic Domains[7]

Putting weight on the word *model*, a business model is an abstraction of reality. A diligently formulated business model can therefore be a powerful tool in business planning and uncertainty management. As Chesbrough & Rosenbloom state, a business model acts as a bridge that interconnects the technical inputs and economic outputs. A well-formulated business model is therefore needed to achieve economic benefit from a technology.

Developing a complete business model is a lot of work. Furthermore, every company is unique in terms of core competencies, resources, culture, and target customer segments. For these reasons, it is impossible to develop detailed business models that would be applicable to all companies. The following simplified working definition is therefore used in this thesis:

> *A business model is a representation of the earning logic of a company. It describes the business environment, revenue sources, and cost structure, and can be used to forecast profitability and revenue streams.*

[7] Chesbrough & Rosenbloom (2002)

2.2. MARKET UNCERTAINTY AND MANAGEMENT STRUCTURE

A network-based service can be provided with varying architectures that involve different management structures. According to Mark Gaynor, a suitable management structure can be a key success factor for a particular firm.[8] Companies have to balance between two extremes: *distributed* or *decentralized management structure* and *centralized management structure*. While the first is flexible and promotes innovation, the latter is efficient and offers business and technical advantages. Therefore, the decision on management structure depends on how important the business and technical advantages are in relation to the ability to experiment. However, constantly changing market conditions cause the optimal management structure to change, which makes the decision difficult.

Gaynor introduced a theory based on real options model that helps to assess the most appropriate management structure in a given market situation.[9] The theory states that *market uncertainty* is the key element that influences the value of innovation relative to business and technical advantages. Innovativeness is most important under high market uncertainty, whereas decreasing market uncertainty increases the importance of efficiency. In other words, as market uncertainty decreases, centralized management structures become more feasible. The terms market uncertainty, network-based service, and management structure are explained next.

MARKET UNCERTAINTY

Introducing a new technology or service always involves risks. It is not sure that a service with new features will meet market demands, because customers' expectations can be unknown. The factor that causes the risks by hindering the ability to predict accurately users' needs is called market uncertainty. Market uncertainty is greatest for emerging services and tends to decrease over time as companies learn about their customers. Gaynor states that the following measures can be used to estimate market uncertainty:[10]

- Ability to forecast the market
- Emergence of a dominant design
- Agreement among industry experts

[8] Gaynor (2001)
[9] Ibid
[10] Gaynor (2003)

- Feature convergence and commodity nature of a product
- Changes in standards activity

NETWORK-BASED SERVICE

Gaynor defines a network-based service, or a network service, as any service provided within or over a data network. This is a broad concept that includes services provided over the Internet, mobile networks and the traditional phone network (PSTN). The services provided over the line to digital homes are by definition network-based services.

MANAGEMENT STRUCTURE

The management structure of a network-based service answers the following questions: Who manages the service, i.e. keeps it up and running? In what part of the network does this management take place? The concept is best explained using a real case, for example consumer e-mail service. Table 1 describes different possibilities to provide e-mail and shows the degree of centralization in each case. Low centralization means that management is distributed to various roles around the network, close to the end users, whereas high centralization means that global players who are unrelated to the users manage the service deeper in the network.

Table 1. Different Management Structures in Consumer E-mail Service

Service type	Typical manager	Characteristics	User control	Degree of centralization
Home server	End user	User runs own e-mail server	High	Low
POP3	Local ISP (e.g. Elisa)	Messages are retrieved to the client and managed by the user	Med	Med
IMAP4	Local ISP (e.g. Elisa)	Messages reside on the server; Only headlines are initially retrieved to the client	Med	Med-High
Webmail	Global player (e.g. MSN Hotmail)	Messages are accessed on a thin client, i.e. web browser	Low	High

2.3. VALUE CHAINS

Value chains and *value systems* introduced by Michael Porter can be used in analyzing companies' cost structures, identifying core competencies, and making strategic decisions. Porter's value chain encompasses the activities within a company or its business unit that are involved in producing a product or a service. The model disaggregates these activities into primary activities and support activities as shown in Figure 3. Primary activities are

directly involved in the physical creation of the product or service, whereas support activities are needed to perform the primary activities.

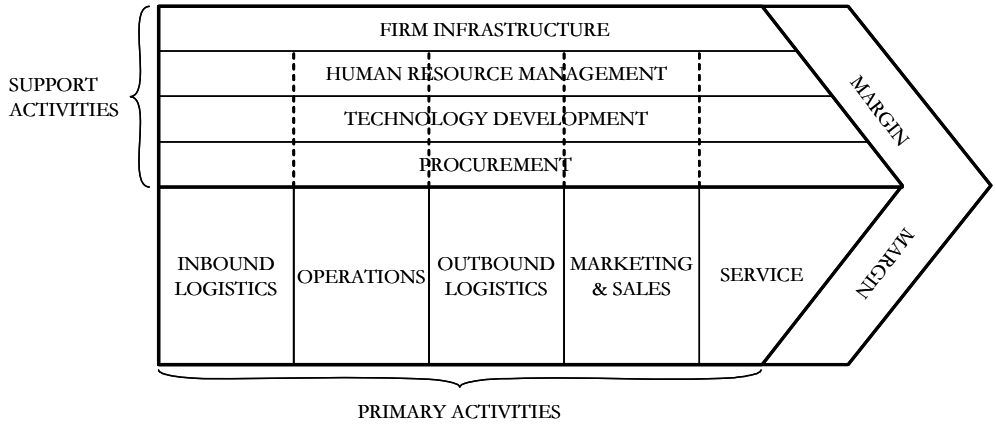

Figure 3. Porter's Generic Value Chain[11]

A value system is conceptually analogous to the value chain but on an industry-wide rather than a company-wide scope. It spans over organizational boundaries by showing all the value chains that are present in the supply chain between suppliers and end customers. The value system shown in Figure 4 hides the details of internal value chains – it is used in positioning the company in the whole industry rather than analyzing the efficiency of its operations. Value systems should not be confused with the value net framework explained in 2.5, since a value system does not take into account complementarities.

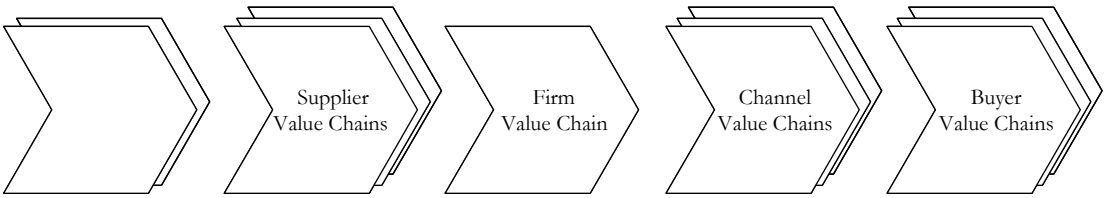

Figure 4. The Value System of a Firm Operating in a Single Industry[12]

The meaning of value chains has expanded over time, partly replacing the use of the value system concept. Today, it is common to see the term value chain being used to refer to the whole supply chain of a product, from raw materials to goods.[13] This thesis uses the term according to the new meaning. If one wanted to use the term in the original Porter's meaning, it would be better to define the term as an *internal value chain* to avoid ambiguity.

[11] Porter (1985)

[12] Ibid

[13] See e.g. Stewart (1995)

2.4. FIVE FORCES OF COMPETITION

A value chain represents the activities of a single firm typically operating in one industry. An industry is commonly defined as a group of firms producing products or services that are close substitutes.[14] The competitors in an industry try to gain competitive advantage with differing value chains. However, the behavior of competing firms is only one component of the overall industry rivalry.

The intensity of rivalry within an industry depends on the industry structure, which is often analyzed using the framework of five competitive forces shown in Figure 5. The forces are: *threat of new entrants*, *bargaining power of buyers*, *bargaining power of suppliers*, *threat of substitute products* (or *services*), *and rivalry among existing firms*.[15] These forces together determine the potential profitability and nature of competition in the industry. The five competitive forces framework was utilized in this thesis in identifying and categorizing uncertainty elements for the scenarios.

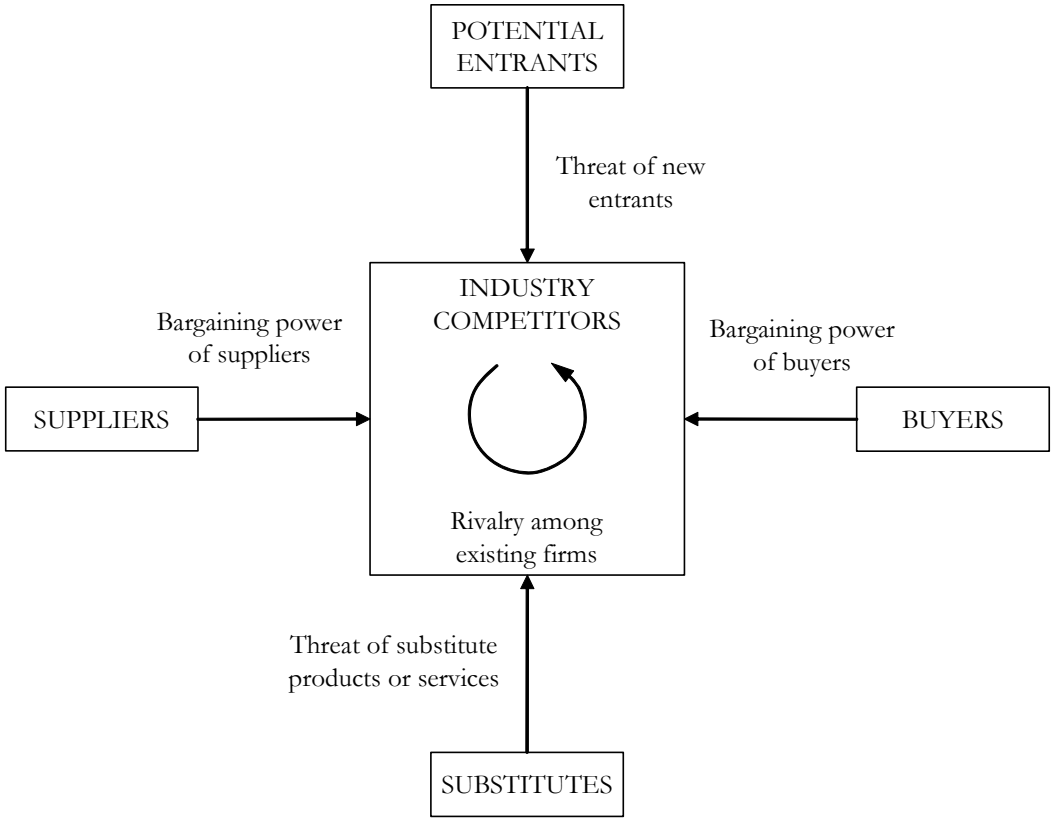

Figure 5. Five Forces of Competition[16]

[14] Hitt et al (2001)

[15] Porter (1980)

[16] Ibid

2.5. THE VALUE NET

Substitute products or services are such that the sale of one makes the other less valuable to a potential customer. Substitutes play a central role in the five forces framework that, however, does not address to complements at all. The *value net* framework introduced by Brandenburger and Nalebuff adds the idea of complements.[17] "Complements are the opposite of substitutes, because the sale of one promotes the sale of another," Porter writes.[18] Examples are for example personal computers and operating systems, or game consoles and compatible games.

While the five forces model describes how a firm within a specific industry has to tackle competitive forces in order to make profit, the value net framework states that the firm also has to manage its complementors, i.e. the firms that produce its complements. Brandenburger and Nalebuff propose that business is a game where the playground is the ecosystem of competitors, complementors, customers, and suppliers. The situation is depicted in Figure 6.

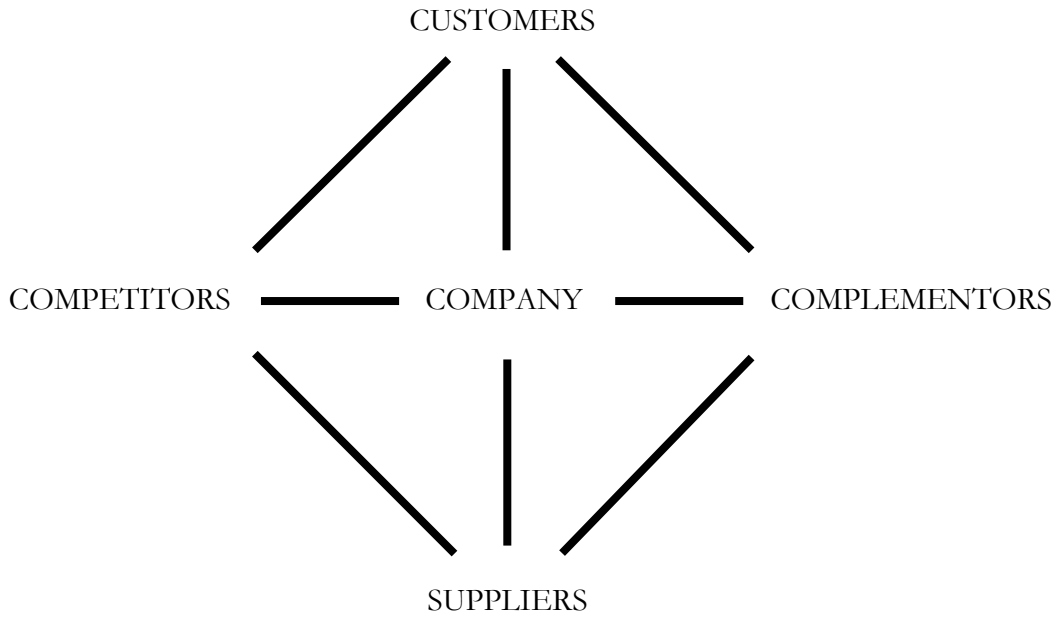

Figure 6. The Value Net[19]

The company in the center interacts in two dimensions. On the vertical axis, the company interacts with its customers and suppliers just as in the value chain model

[17] Brandenburger & Nalebuff (1995)

[18] Porter (1985)

[19] Adapted from Brandenburger & Nalebuff (1996)

discussed above. On the horizontal dimension are the players who affect the company's business but with whom the company does not directly transact.

Complementors may bring significant benefit to a company. As Brandenburger and Nalebuff formulate the case, "When a complementor enters the game, the pie grows. That's win-win."[20] On the other hand, there is the problem of sharing the pie: if someone gets a bigger piece, less is left for the others. Corporate managers should put effort of managing complementor relationships to ensure that there will be complements available for their offerings. Yoffie and Kwak state that this can be a challenging task, because it is often hard to understand complementors' economics, strategies, capabilities, incentives for cooperation, and potential areas of conflict.[21] The problem arises because there is often a big difference between the firm's and its complementor's business models.

In addition to Brandenburger and Nalebuff, several other authors have written about frameworks that the authors call either value nets or value networks.[22] Nevertheless, in this thesis, the terms value net and value network are used interchangeably, and they point exclusively to the framework by Brandenburger and Nalebuff.

The value net framework is used in section 6.1 as a tool for structuring the ecosystem consisting of various players who have roots in networks, hardware, or content and applications.

2.6. INDUSTRY SCENARIOS

Scenarios are a strategic planning tool that can be utilized in any industry. They are particularly valuable at times of high uncertainty, when finding rationale for decision-making is hard. Scenarios can be developed on different scales, from high-level macro scenarios that touch the business of every company in the world to company-specific micro scenarios to help make a particular decision. A scenario is not a forecast but a

[20] Ibid

[21] Yoffie & Kwak (2006)

[22] See e.g. Allee (2000) and Parolini (1999).

description of a possible future. As Michael Porter defines scenarios on an industry scale, "An industry scenario is an internally consistent view of an industry's future structure." [23]

According to Peter Schwartz, the ultimate idea of scenario thinking is to give decision-makers a space of possible outcomes, so that they can prepare for any of them.[24] The idea is not to bet on the most probable scenario, but to become flexible to quickly change the organization when the direction of development clarifies. A scenario planning process always results in two or more scenarios – a single scenario would be just one guess about future, and it could come either true or not. Such a guess would provide little value to decision-makers.

Kees van der Heijden presents the following principles that can be used as guidance in scenario development:[25]

- There has to be at least two scenarios to reflect uncertainty. More than four is often too complex to deal with.
- Each scenario must be plausible. The scenarios must show logical evolution from the past to the present.
- The scenarios must be internally consistent: the events within a scenario must have cause/effect relations.
- They must be relevant to the issues that are being researched.
- The scenarios must provide new ideas and insights that can be useful in strategic planning.
- They must produce a new and original perspective on the problem.

As long as the scenario planner conforms to the above rules, he or she can flexibly choose the method to construct the scenarios, decide what to include in the descriptions, and decide how to cut up the territory into individual scenarios.

To get use of a scenario, it is not sufficient just to describe a future situation. One must be able to seamlessly explain how the world could develop from the present situation to the one described in the scenario. Van der Heijden says that a scenario "is a story, a

[23] Porter (1985)

[24] Schwartz (1998)

[25] van der Heijden (1996)

narrative that links historical and present events with hypothetical events taking place in the future."

In addition to the already mentioned scenario thinkers, Pierre Wack is renowned as one of the forefathers of the methodology. Wack, Schwartz, and van der Heijden all have a background in the Royal Dutch/Shell Group, where scenario planning was refined as a technique for business prognostication in the early 1970s.[26] There are several approaches to scenario construction. Some of them are highly structured processes like the one described by Porter and depicted in Figure 7.[27] Some of them, on the other hand, give more freedom to the scenario planner.

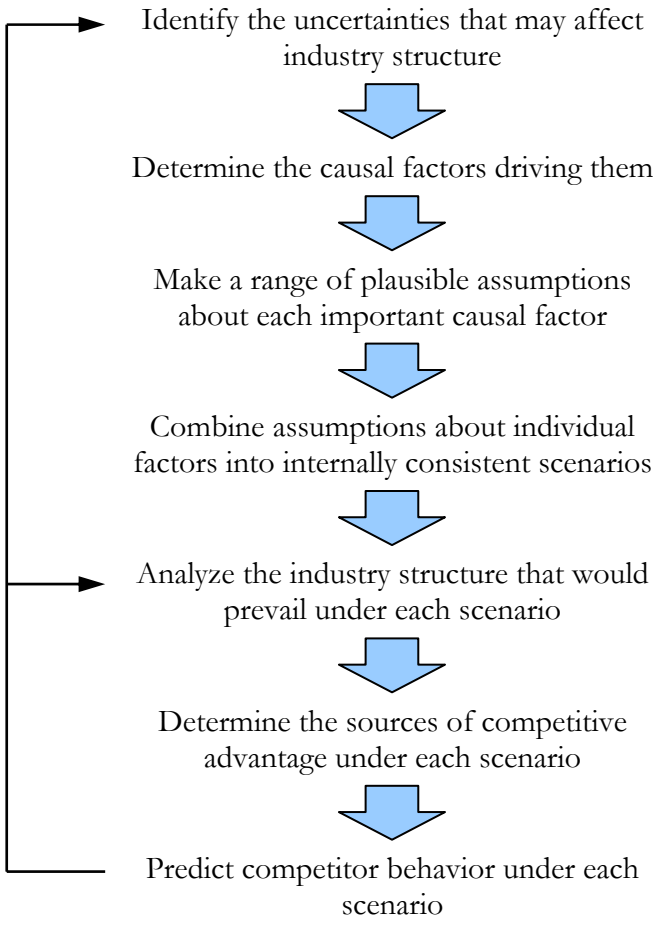

Figure 7. The Process of Constructing Industry Scenarios by Porter[28]

Despite the fact that there are differences between scenario construction frameworks, all frameworks build on driving forces, which have *predetermined elements* and *uncertain*

[26] Schwartz (1998)

[27] Porter (1985)

[28] Porter (1985)

elements. Predetermined elements are events that have already occurred or very likely will occur but whose consequences have not yet unfolded.[29] For example, it is known that population is aging in the postindustrial European countries, but it is yet unclear how this will affect the economy. Only if all the elements of a future are predetermined can it be forecast accurately. In real life, there are always uncertainties though, and both predetermined and uncertain elements should be paid attention to.

The scenario thinking logics adapted to this study are fundamentally based on the ideas of Peter Schwartz.[30] His ideas are applied in the book Wireless Foresight: Scenarios of the mobile world in 2015, and a similar method is used here.[31] The processes of choosing the framework and developing the scenarios are explained later in this thesis.

[29] Wack (1985)

[30] Schwartz (1998)

[31] Karlson et al (2003)

3. Management of Digital Homes

This chapter gives an overview of the concepts of *digital homes* and *management of digital homes*. It first describes the devices and services in digital homes, and presents current digital home offerings. Then it describes the essential enabling technologies, and finally guides the discussion into management services. At the same time that this chapter gives a general view on digital homes, it acts as an introduction to the scenarios constructed later in this thesis.

3.1. Introduction to Digital Homes

3.1.1. Definitions of Home Network and Digital Home

This thesis considers home networks in a rather broad meaning. A home network features a range of digital devices connected to each other using wired or wireless technologies. The connection to the public network is an essential element of the home network. Network technologies can be chosen freely, and in a typical case, there are several technologies simultaneously in use within the same network.

The terms *home network* and *digital home* are often used interchangeably. However, when talking about a home network one may refer either to the wired and wireless network connections between devices, or to the whole system consisting of the connections and the devices. Digital home is a less ambiguous term, because it intuitively refers to the digital home system as a whole, including networks and devices. This study considers the two terms as equal, i.e. a home network refers to the whole digital home, unless mentioned otherwise.

3.1.2. Devices in the Digital Home

This section describes some devices that have a special importance in digital homes. According to Current Analysis, already 60% of desktops and 50% of laptops sold in the U.S. retail channel are media center PCs.[32] Therefore it is justified to take a PC-centric approach to home networks. Even though it is possible that an intelligent central device arises from the CE industry, at least for the moment it seems that the PC is going to be the dominating device in the digital home. Figure 8 shows the setting of an example

[32] Duboise (2006)

media center based digital home. For simplicity, the intra-home connection types are not shown in the figure. In reality, users can implement the network connections in various ways, and the implementations depend on conditions such as supported network interfaces of devices, possible existing wirings in the home, and user preferences.

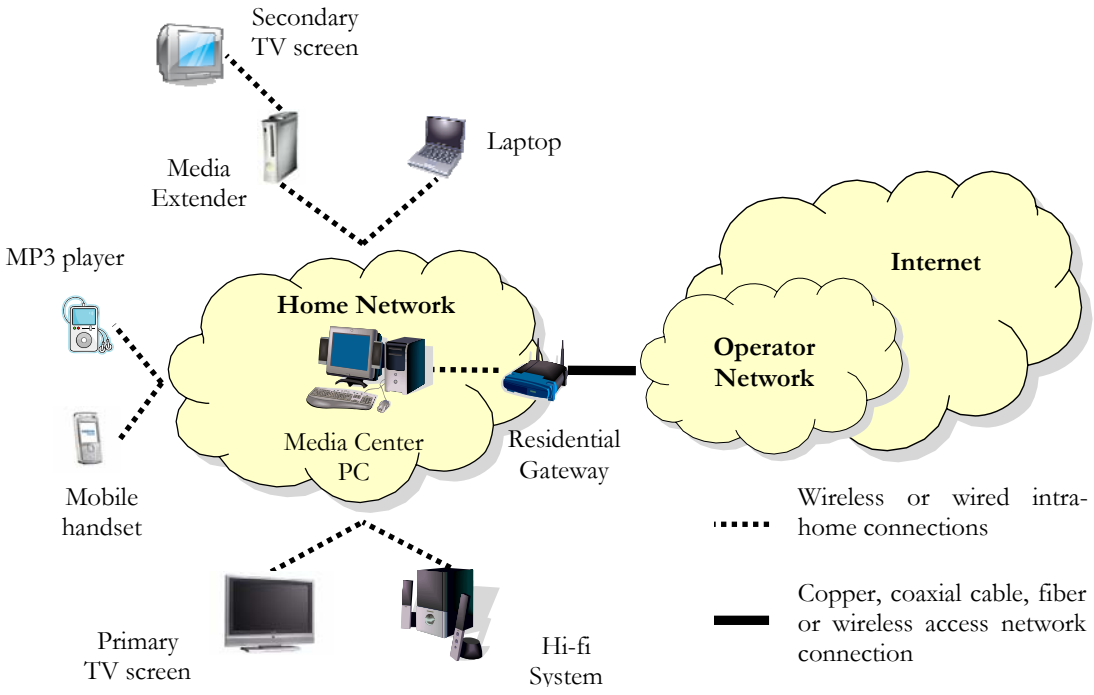

Figure 8. Example of a Digital Home

MEDIA CENTER VS. PERSONAL COMPUTER

A media center is a home computer with enhanced media capabilities. The media center's hard drive acts as a central repository for all the information needed in the home environment, which relieves users from the synchronization problems that are otherwise common in a multi-device environment. The terms *media center* and *media server* are sometimes used interchangeably, but this study makes a difference between them. A media server is understood as a plain storage for digital media, such as music, video, photos, and electronic books. This definition leads to the perception that PCs, digital video recorders, cameras and camcorders, and digital audio players such as MP3 players all are media servers. The term media center is more limiting: a media center is a PC (and therefore a media server) with an additional user interface for the express purpose of using entertainment functions, and it can be controlled by a remote control. The traditional mouse and keyboard are impractical controllers in a typical use case, where the user sits on the living-room couch rather than in front of a desk.

The media center may be a common PC that is used for gaming, running applications and other traditional tasks in addition to utilizing its media capabilities, or it may be a special purpose PC styled to be part of the living room furniture. A TV tuner card is required to receive broadcast television or radio programs. They can be recorded to the hard drive or streamed to output devices, such as televisions or stereo systems. The widely spread Microsoft Windows XP MCE (Media Center Edition) is a Windows XP operating system with additional media center capabilities.[33] Similar capabilities are included in some versions of the new Windows Vista.[34] Microsoft's home networking solutions are discussed more in 3.1.5.

MEDIA EXTENDER

A media extender adds a new control point to the digital home. It has a similar user interface as the media center, and the files stored on the media center can be accessed through this interface. The value is that the media center can be utilized simultaneously for two different purposes, and the users can be in different rooms. As seen in the example configuration in Figure 8, the primary TV screen is connected directly to the media center, and a secondary TV screen is connected to the media extender that might reside in the children's playroom, for instance. Media extender functionalities can be integrated into more general-purpose devices, as has been done for instance with Microsoft's XBox 360 game console.

RESIDENTIAL GATEWAY

A residential gateway (RGW) is a central device that allows the home devices to share a single IP address using network address translation (NAT). An xDSL or cable modem is often integrated into the gateway, which thus provides Internet access by connecting the home network to the public network through a local telecom or cable television operator. The residential gateway may act as a WLAN access point, Ethernet switch, IP router, and firewall. If the modem is a separate device, it stands between the residential gateway and the operator's network.

[33] Windows XP Media Center Edition 2005 Web page: http://www.microsoft.com/windowsxp/mediacenter/default.mspx (Accessed November 20, 2006)

[34] Windows Vista Web page: http://www.microsoft.com/windowsvista/ (Accessed November 20, 2006)

Mobile Handset

Mobile handsets play a special role in home networking, because they have the unique nature of providing ubiquitous connectivity. When at home, they connect to other devices using PAN or LAN technologies such as Bluetooth or WLAN and, when away, they can reach home for example with GPRS or WCDMA. Different technologies are discussed in 3.2.

Other Devices

There are numerous devices that can be connected to expand the digital home experience, and more are introduced all the time. Depending on user needs, there may be printers, television screens, audio systems, portable devices and so on. These are not discussed in this thesis, but it is important to note that new networked devices offer new application areas, potentially providing opportunities for service firms. To describe the digital readiness of Finnish people, Table 2 presents the penetration of some devices and connections in Finnish households.

Table 2. Penetration of Some Home Network Elements in Finnish Homes in August 2006[35]

Mobile	%
Mobile Phone	97
WAP/GPRS/3G Phone	46
Camera Phone	46
MP3 Player	33

PC Internet	%
Personal Computer	70
Laptop	29
Recording CD-ROM/DVD	50
Internet Connection	63
Broadband Internet	53
IP Telephone Subscription	23

Consumer Electronics	%
Television	95
Widescreen or Plasma/LCD TV	35
Cable TV or Satellite Dish	48
Digital TV or Set-Top Box	51
DVB-T or DVB-C	48
DVB-S	5
Set-Top Box with DVR	13
DVD Player	50
DVD Recorder	13
Home Theater System	20
Camcorder	22
Digital Camera	52
Game Console	24

The total number of households was 2,415,000

[35] Statistics Finland (2006)

3.1.3. Three Technology Islands

The Digital Living Network Alliance (DLNA) is an industrial alliance whose members are top companies from mobile device, consumer electronics, and computing industries.[36] DLNA creates and delivers guidelines based on open industry standards. The goal is to ensure interoperability between devices originating from any of the abovementioned industries. DLNA's interoperability guidelines do not specify the whole design for a home system but smaller building blocks that enable companies to build platforms and software infrastructure on top of them. DLNA also acts as a certification agency that gives products conforming to its requirements the right to carry the "DLNA Certified Logo" shown in Figure 9.

Figure 9. The DLNA Certified Logo[37]

For the time being DLNA focuses on interoperability in entertainment and media context, i.e. between devices for imaging, audio and video. Other areas will be covered over time, for example home automation, communication, and advanced entertainment. Table 3 presents the current interoperability guideline elements.

Table 3. DLNA Interoperability Guideline Elements[38]

Functional Components	Technology Elements
Network Connectivity	WLAN, Ethernet and Bluetooth
Networking Protocols	IPv4 Protocol Suite
Media Formats	JPEG, LPCM, MPEG2
Device Discovery and Control	UPnP Device Architecture v1.0
Media Management and Control	UPnP AV v1 and UPnP Printer:1
Media Transport	HTTP 1.0/1.1

[36] DLNA Web page: http://www.dlna.org/ (Accessed October 22, 2006)
[37] DLNA (2006)
[38] Ibid

This thesis shares the DLNA's view of digital convergence illustrated in Figure 10. There have traditionally been three distinct islands in the home: the PC world, the CE broadcast world, and the mobile world. Now the boundaries between the islands are vanishing along with increasing interoperability. The technological islands are elaborated below.

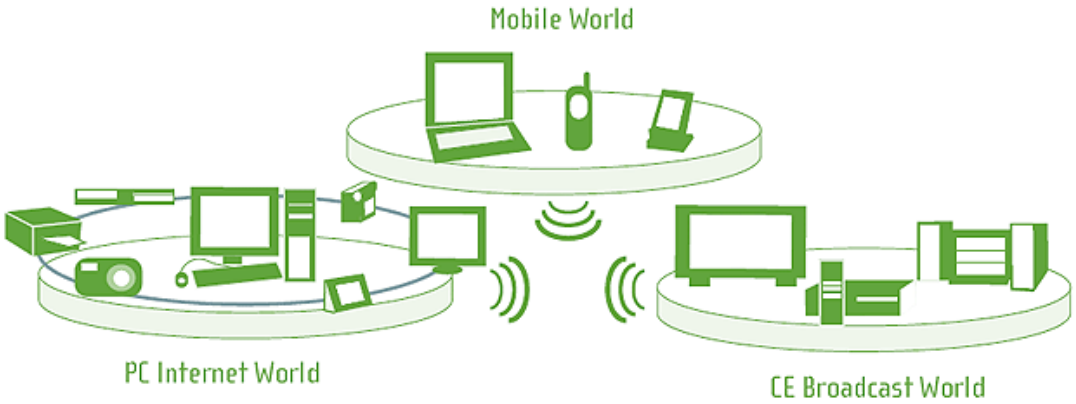

Figure 10. The Three Technological Islands[39]

PC World

The PC world consists of personal computers and their peripherals that communicate with each other. Typical devices are desktops, displays, digital cameras, printers, and scanners.

Mobile World

The common denominators for devices in the mobile world are ubiquitous connectivity and mobility both inside and outside the home. Smart phones, PDAs, MP3 players and laptop computers are some examples of devices belonging to the mobile world.

CE Broadcast World

The consumer electronics broadcast world encompasses the traditional CE devices that are usually located in the living room, and the newer set-top boxes that have emerged with the digitalization of television.

[39] Ibid

INTERCONNECTING THE ISLANDS

Home networks are about bringing the islands closer to each other. DLNA's role in making this happen is the certification program: a device that comes with the certificate logo is able to connect with any other certified device, regardless of which islands the devices are originally from.

Besides the fact that the devices are connected to each other at home, the home network is connected to the public network. There are several possible links between the home and the outside world: mobile networks, fixed and wireless broadband access networks, and broadcast networks. Connectivity is discussed more in 3.1.4.

3.1.4. Services in Home Networks

As mentioned earlier, one of the goals of this thesis is to study business models. Services typically enable more innovative business models than traditional product sales, and that is why services are paid special attention here.

SERVICES AND CONTENT

This subsection defines the terms *service* and *content* in a digital context as they are used in this work.[40] Related to this confrontation, economists have been debating the definitions of *services* and *goods* for over two centuries, and still, no universal definitions exist that would apply to any industry.[41] In this thesis, a service is specified as an immaterial product, i.e. a product that is consumed at the same time it is provided; this also leads to the fact that it cannot be stored. A good on the other hand can be stored and consumed at some time after the transaction.

Digital content is information that may be manifested in various forms, such as text documents, Web pages, music, images, video, and games. For the purpose of this thesis, only content that is delivered over a network is relevant.[42] Content can be provided as a service or as a good. Examples of content services are streaming, online gaming, and television broadcasts.

[40] Digital context means that information is presented in a digital form, e.g. in the Internet, in digital broadcast networks, and in mobile networks.

[41] Gadrey (2000)

[42] Digital content can be also stored and delivered in a physical form, e.g. CDs or DVDs.

When talking about content, Digital Rights Management (DRM) solutions obscure the difference between services and goods. They separate licenses from the actual content, enabling service models such as pay-per-use, rental, subscription, and try-before-buy.[43] From the user point-of-view, some of these are hybrids of goods and services, because the content is fully downloaded into the user terminal, but the user does not have free access to it.

TWO SERVICE LAYERS

Viewed from the supplier side, services offered into digital homes can be divided into connectivity layer and content & value added services layer as illustrated in Figure 11. The layers are explained below.

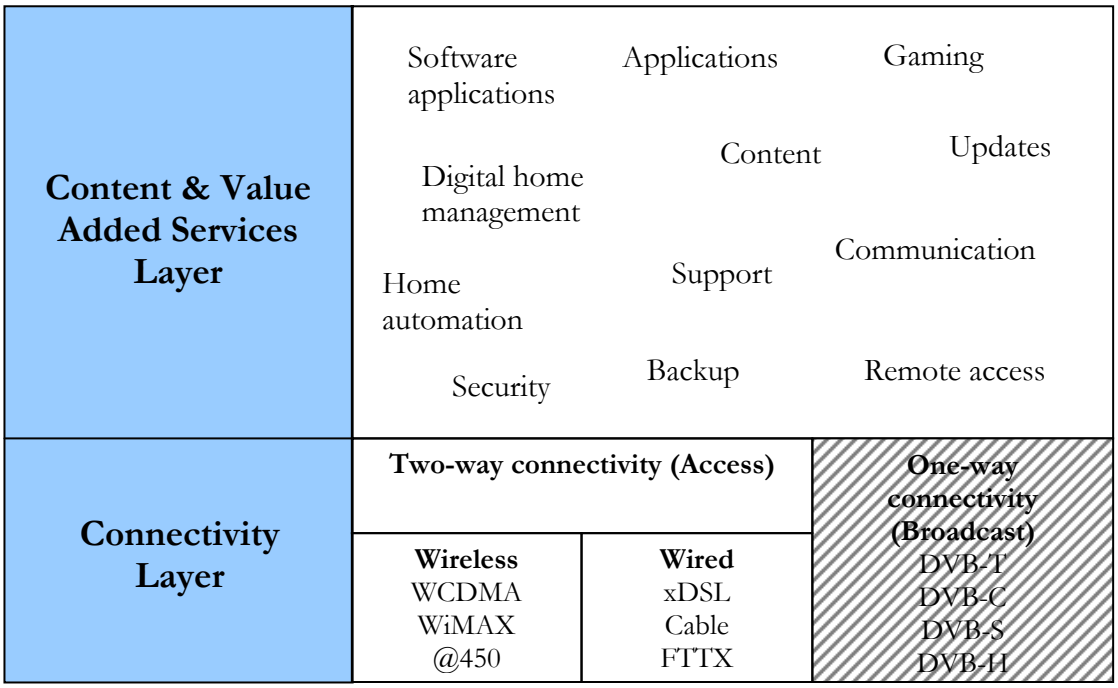

Figure 11. Service Layers

CONNECTIVITY LAYER

Connectivity is the service that enables moving data from the public network to the home and vice versa. Connectivity has a special role compared to other services, since they cannot be offered without connectivity. One can identify four different types of connectivity that link homes to the public network:

1. Two-way fixed broadband, e.g. xDSL, Cable modem, FTTX
2. Two-way wireless broadband and mobile, e.g. WCDMA, HSPA, WiMAX, @450

[43] Liu et al (2003)

3. Broadcast, e.g. DVB-T, DVB-C, DVB-S
4. Mobile broadcast, e.g. DVB-H

The two last mentioned are one-way broadcast networks that fall outside the scope of this thesis. This is why the lower right corner is covered with gray stripes in Figure 11. Each connectivity type has its own applications, but from the user perspective, the differences between the technologies are obscuring because of technological convergence. After all, if all the networks are based on IP, it should not make any difference for the user what medium an IP based service is delivered through.

CONTENT & VALUE ADDED SERVICES LAYER

This layer includes everything that can be offered when connectivity is first established. Figure 11 presents some key services, and Table 4 below shows one way to write them out. The list is not exhaustive, since there are countless services and more are created all the time. It is important to note that although digital home management is mentioned just as one of the services, it has an exceptional role affecting all the other services. The table could actually be reorganized so that security, support, file backup, and remote access were all put directly under digital home management. Management services for digital homes are discussed later in this thesis.

Table 4. List of Important Value Added Services

Content	**Home automation**
Entertainment	HVAC
Information	Lighting
Place shifting	Access control
Time shifting	Home appliances
Security	**Support**
Firewall	Online manuals
Virus software	FAQs
Malware detection	Telephone support
Spam filtering	On-site technicians
Parental control	Remote configuration
Updates	**Digital home management**
Communication	**Remote access**
E-mail	**File backup**
Telephony	**Gaming**
Instant messaging	**Software applications**

There are many ways to categorize offerings that fall on the content & value added services layer. One alternative is to take the user point of view to the digital home, as shown in Table 5.

Table 5. Usage Categories in the Digital Home[44]

Entertainment and Creativity Applications
Acquire, store, manage and play digital music
Easily acquire, manage and view digital photos
Facilitate personalized TV recording and viewing
Access and view movies in a variety of ways
Perform all of these kinds of tasks wirelessly, for end users on the go
Gaming Applications
Download and play games individualized to preferences
Play games over the network against computers or other players
Educational Applications
Enhance learning with research, online tutorials, test preparation, specialized education and so on
Start a new hobby
Communication Applications
Stay in touch with friends, partners, employers and others—using any device
Enjoy richer, converged communications employing a variety of media types
Practical Applications
Pay bills and shop online
Control, monitor and reduce costs associated with energy use and appliances
Gain ready access to information around the home and control systems, such as security systems, heating and cooling, lighting and so on

3.1.5. Current Digital Home Offerings

Many companies representing personal computing, consumer electronics, software, and mobile communications industries have introduced products that fit into the digital home. The offerings range from software platforms and user interfaces to wide product

[44] Intel Web page: Planning for the Digital Home: Business Models & Usage Categories. See: http://www3.intel.com/cd/ids/developer/asmo-na/eng/229455.htm (Accessed October 23, 2006)

families that build up a whole entertainment system. Some solutions that are central to this research are discussed in the following subsections.

MICROSOFT

Microsoft seems to be trying to keep the intelligence of the digital home within its control. This can be perceived in Microsoft's offerings that include the Windows OS with Media Center platform, XBox 360 game consoles, remote controllers, and even the Windows Mobile platform for mobile handsets. These elements can be considered intelligent in the sense that the user can perform advanced tasks with them, such as control other home devices, record television programs, or play programs stored on hard drives or DVDs.

Microsoft leaves the provision of "dumb devices" to other companies. In contrast to intelligent devices, dumb devices are functionally simple, performing only the narrow tasks they are designed to. Examples are output devices such as display screens and stereo systems, and plain set-top boxes with no recording functionality.

Microsoft has recently made moves to strengthen its position in the content market as well. On November 22 of 2006, the XBox Live service started to offer television shows and movie downloads, both in standard-definition and high-definition quality.[45] The earlier XBox Live service provided mainly game downloads and multiplayer gaming services, so this reform transitions the XBox 360 game console more into a multi-purpose entertainment device. This is supported by the fact that XBox 360 comes with built-in media extender capabilities.

The new Zune portable music player provides evidence on Microsoft's entrance in the digital audio market ruled by Apple's iTunes Music Store and iPod players.[46] With a strategy resembling closely to Apple's, Microsoft opens up a Zune marketplace which is dedicated to bringing together owners of the player, and providing compatible content and accessories to it. What differentiates Zune from other music players currently available is its wireless capability. The Zune users can connect to each other or to home networks using 802.11 WLAN connections.

[45] Microsoft (2006)

[46] Zune Web page: http://www.zune.net/en-US/ (Accessed November 30, 2006)

Apple Computer

As mentioned above, Apple is the reigning player in the portable music player and digital audio content business. This is the area where the company still has a stronger position than its archrival Microsoft. The 2003 opened iTunes Music Store is the world's largest online store for songs, and after full-length movies were recently added to the catalog it has potential to be the leading commercial place for video downloads, too.[47]

Apple also has its own software platform for home entertainment purposes. The iLife application suite used together with a free Front Row application enables more or less similar functions to Windows XP MCE.[48] Today, Apple ships both its desktop and laptop computers pre-equipped with iLife and Front Row, a remote controller, and Airport Express WLAN solution.

Apple TV is a new device that connects computers to televisions.[49] It plugs into a television and connects to a PC or Mac using a wireless 802.11n network. Content stored on a computer can be synchronized to Apple TV's hard drive using iTunes software, or Apple TV can be used as a media extender to choose and stream content directly from a computer to the TV. Besides increasing hardware sales, the business rationale behind Apple TV is probably that it will boost video downloads from the iTunes store, since it makes enjoying videos more convenient.

Nokia

Nokia extends the digital home offering by developing mobile handsets that connect to the home network. Nokia proposes that its devices will be fully interoperable with other home devices such as PCs, televisions, and home music systems, making the mobile handset an additional playback and storage device.[50] Compared to other devices, the special characteristics of mobile handsets are personality and ultimate mobility. Mobile handsets enable creation of new value because of two particular reasons: 1) they enable provision of personalized services, and 2) they extend the digital home outside the home premises.

[47] Apple (2006)
[48] iLife '06 Web page: http://www.apple.com/ilife/ (Accessed December 1, 2006)
[49] Krazit (2007)
[50] Nokia (2005)

Nokia's view of convergence shows in its multimedia handsets that combine the functionalities of a mobile phone, digital music player, radio, camera, web browser, e-mail client, and recently also television. This is convenient for the users in the sense that all the capabilities are always carried along, and can thus be taken into use at any time. At the moment Nokia's multimedia devices, however, do not reach the same performance as for example standalone MP3 players that have more storage capacity, cameras that have better optics, and so on. In addition, perhaps most importantly, standalone devices usually have a lot longer battery lives than convergence devices.

Ever since Nokia started to divest its non-telecom businesses in the early 1990s, it has been increasingly concentrating on communications. Among the latest steps was selling the digital set-top box business some time ago, so now Nokia is quite well focused on mobile communications and mobile applications. The expertise on television and set-top box manufacturing however shows in DVB-H development, where Nokia is among the pioneers.

To gather up what Nokia is doing in the field of home networking, it is extending the digital home outside the customer premises. Nokia's devices enable similar services as those that reside at home, but the user is not tied to any single place. The multimedia handsets often have several radio interfaces, including GSM or WCDMA, WLAN, and Bluetooth. The choice of which technology to use depends on the situation. Interesting recent additions to the product line are the 770 and N800 Internet Tablets, which are not mobile phones but are designed to be used in a WLAN network, for example in a digital home.

Place Shifting Service Providers

Sling Media, Inc. is a forerunner in digital convergence products that enable a type of service that is new in live multimedia context, called *place shifting*.[51] The well-known service *time shifting*, enabled by VCRs and DVRs, means that content is played in the same place but at a different time than it is broadcast.[52] Place shifting, in contrast, means that digital content is streamed over a network and played in a different place, using a

[51] Sling Media Web page: http://www.slingmedia.com/ (Accessed November 27, 2006)

[52] DVR stands for *Digital Video Recorder*. *Personal Video Recorder* (PVR) is another widely used term.

remote device connected to Internet.[53] The shifted content may be live television broadcast or it may be prerecorded to the hard drive of a DVR or PC.

Sling Media's two main products are Slingbox and SlingPlayer. The Slingbox is a hardware device that is located at home between the content source and the DSL or cable modem. It receives content from, say digital cable box, transcodes it into MPEG-4, which is then sent to the home network's gateway with an Ethernet cable. SlingPlayer is the software application that is installed to the remote device to make it able to connect to the Slingbox and control the video source device. Initially the software worked only in Microsoft Windows based computers, PDAs, and mobile handhelds but the company is extending compatibility to other platforms as well.

Although Slingbox is used here as an example for place shifting, there are also other solutions available. Sony's LocationFree offers similar functionalities. In addition, Sony sells portable WLAN-capable televisions and PSP gaming devices that are able to play streamed content.[54] In addition, various software applications provide place shifting for different devices and different media types. Companies providing these applications include e.g. Orb Networks, Oxy Systems, Avvenu, Sharpcast, Vizrea, and CMWare.[55]

3.2. KEY ENABLING TECHNOLOGIES

This section describes technologies that are essential in the digital home environment and for providing services into digital homes. Figure 12 shows a categorization of network technologies based on the size of geographic areas they cover. A rule of thumb is that personal area and local area networks are suitable for intra-home connections, while metropolitan area and wide area networks are suitable either for providing Internet access from home or for mobile connectivity. The rule has exceptions though. For instance, LAN technologies such as IEEE 802.11 family can be used to create hotspot networks, through which homes can connect to the Internet.

[53] Also taking a remote connection to the employer's server is called place shifting. Place shifting work is more mature a service than place shifting live television.

[54] Sony LocationFree Web page: http://products.sel.sony.com/locationfreetv/flash.html (Accessed November 27,2006)

[55] Company Web pages: http://www.orb.com/, http://www.oxysys.com/, http://www.avvenu.com/, http://www.sharpcast.com/, http://www.vizrea.com/welcome.aspx, and http://www.cmware.net/ (Accessed November 27, 2006)

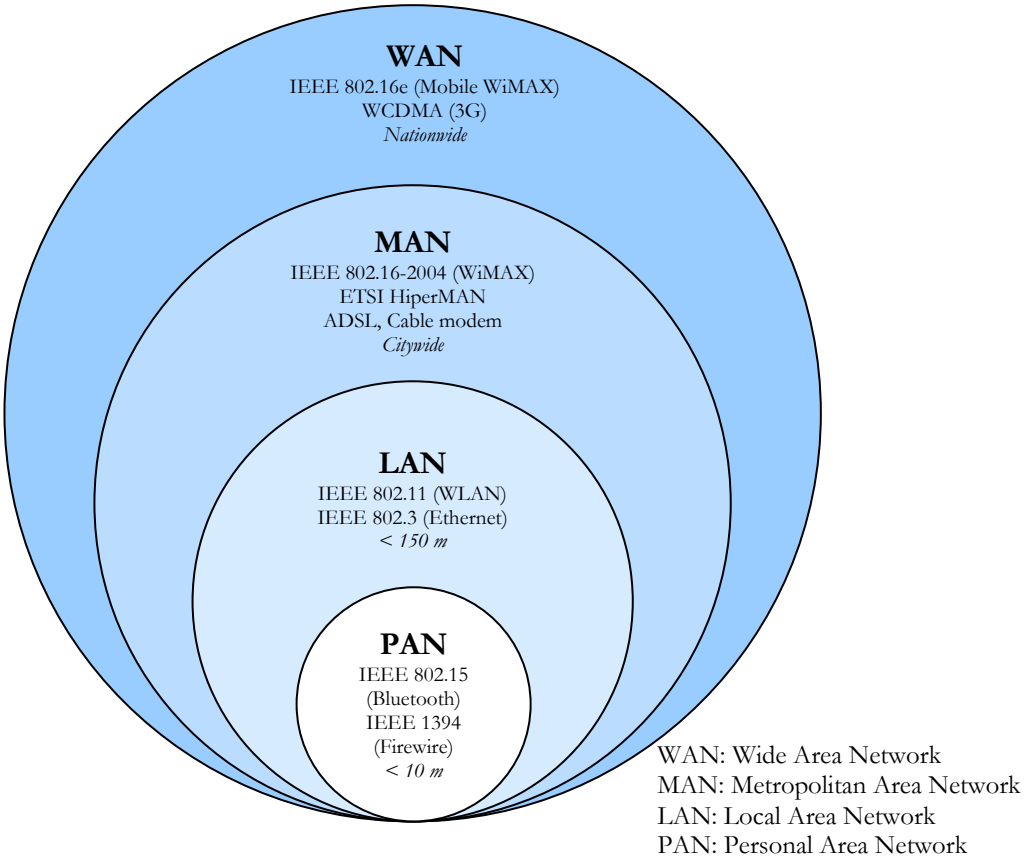

Figure 12. Typical Network Ranges[56]

3.2.1. Access Network Technologies

Access network technologies enable connectivity to the Internet. The selection of available technologies varies by geographic location, because rural areas often lack the infrastructure that urban areas have. There will be no single winning access network technology. As one of the experts interviewed for this thesis mentioned, the technology that is techno-economically most efficient in a particular geographic area will rule.[57] In practice, this means that wireless technologies will be used in rural areas, and wired technologies will be used in urban areas. It is cost-effective to build a wireless network with large cells because the distances between base stations can be long and therefore the number of base stations needed is moderate. However, the capacity of a wireless cell is always shared among the users within that cell area, so large cell sizes are not suitable in densely populated areas. In addition, the cell capacity is negatively correlated with coverage: the larger the capacity the smaller the coverage. Therefore, using wired

[56] Based on OECD (2006), modified

[57] Expert interviews conducted between September 21 and October 24, 2006.

connections is often a better choice in cities. Installing new wires is expensive, but urban areas often have existing infrastructures that can be utilized. These include telephone networks, cable TV networks, and increasingly fiber-based networks. Some relevant MAN and WAN technologies that are in commercial use in Finland in 2007 are compared in Table 6.

Table 6. Comparison of Commercially Available MAN and WAN Technologies[58]

Wireless

Technology	Data rate downlink (max)	Data rate uplink (max)	Advantage	Disadvantage	Use case
WCDMA	384 kbps	128 kbps	Wide coverage, lots of users	Limited speed	Mobile handsets, laptops
HSDPA	2 Mbps	384 Mbps	Upgrades 3G networks, low latency		
@450 / Flash-OFDM*	1 Mbps	512 kbps	Large cell size, cheap to build	Limited speed, no QoS	Portable devices in urban areas, last mile access in rural areas
IEEE 802.16d Fixed WiMAX	10 Mbps	5 Mbps	Often cheaper to build than DSL in rural areas	Expensive terminals, capacity shared within a cell	Last mile access in rural areas

Fixed

Technology	Data rate downlink (max)	Data rate uplink (max)	Advantage	Disadvantage	Use case
Cable modem (EuroDOCSIS)	10 Mbps	1 Mbps	Utilizes excess CATV network capacity	Cable network availability not as good as telephone network availability	Last mile access in CATV homes
ADSL / ADSL 2+	24 Mbps (1.5 km)	1 Mbps (1.5 km)	Utilizes telephone networks	Speed depends on distance from closest exchange	Last mile access

* The @450 network is operated by Digita Oy. It will be opened on April 1, 2007.

The table shows that downlink data rates are in the available offerings greater than uplink data rates. This fulfills well the needs of users whose network behavior is download-oriented. Web surfing, file downloading, and streaming are examples of this kind of usage. However, recently emerged application areas, such as P2P file sharing, VoIP, video calling, and network file storages have increased the need for high uplink speed as well.

[58] Sources: Finnish operators TeliaSonera (http://www.sonera.fi/), Saunalahti (http://saunalahti.fi/), Elisa, http://www.elisa.fi/), Maxisat (http://www.maxisat.fi/), and Digita (http://www.digita.fi/). (Accessed January 23, 2007).

Balanced against the current technologies, Table 7 presents some MAN and WAN technologies that are not yet in commercial use.

Table 7. Comparison of Future MAN and WAN Network Technologies[59]

Wireless

Technology	Data rate downlink (max)	Data rate uplink (max)	Advantage	Disadvantage	Use case
IEEE 802.16e Mobile WiMAX	~10 Mbps	~5 Mbps	Coverage	Mobile WiMAX license required	Portable devices in urban areas, last mile access in rural areas
HSPA*	~10 Mbps	~5 Mbps	Coverage, low latency	3G license required	Mobile handsets, laptops

Fixed

Technology	Data rate downlink (max)	Data rate uplink (max)	Advantage	Disadvantage	Use case
Cable modem (DOCSIS 3.0)	160 Mbps	120 Mbps	Utilizes excess CATV network capacity	Cable network availability not as good as telephone network availability	Last mile access in CATV homes
VDSL	100 Mbps (0.5 km)	100 Mbps (0.5 km)	Utilizes telephone networks	Speed depends on distance from closest exchange	Last mile access
Fiber (FTTH)	> 1 Gbps	> 1 Gbps	High capacity	High initial investments	Last mile access in urban areas, backbone networks

* HSPA = HSDPA + HSUPA

3.2.2. Intra-home Network Technologies

Intra-home technologies are used to connect devices with each other within the home. There is a wide selection of wireless and wired standards, as can be seen in Table 8. The standards differ from each other by characteristics such as speed, range, power consumption, and transfer medium. There is no all-embracing technology covering all applications at home. According to the industry experts, there will be both wired and wireless connections in the future digital homes.[60] The links that carry the most traffic will be implemented with Ethernet-type wired technologies. Such core connections are for example the links between the residential gateway, the main PC, and the primary entertainment center. Other connections will be either wired or wireless. The choice of the connection technology between two particular devices depends on various elements,

[59] Sources: OECD (2006), CableLabs (2006), Qualcomm (2004), Gray (2006)

[60] Expert interviews conducted between September 21 and October 24, 2006.

including available network interfaces in the devices, mobility requirements, power consumption, and speed requirements.

Table 8. Comparison of Intra-home Technologies[61]

Wireless

Technology	Supporting organization	Max. data rate	Max. distance	Advantage	Disadvantage	Use case
IEEE 802.11a/b/g	Wi-Fi Alliance	11/54 Mbps	30-100 m	Fast, popular	Microwave interference	Data and A/V connections
IEEE 802.11n (July 2007)	Wi-Fi Alliance	540 Mbps	50 m			
Bluetooth v.1	Bluetooth SIG	723 kbps	10 m	Low power and cost	Microwave interference, limited speed	Connecting personal devices
Bluetooth v.2	Bluetooth SIG	3 Mbps	100 m			
IEEE 802.15.3 (UWB)	WiMedia Alliance	> 100 Mbps	10 m	Low power	Coverage	A/V connections
IEEE 802.15.4	Zigbee Alliance	250 kbps	30 m	Low power and cost	Limited speed	Sensors and control devices

Wired

Technology	Common name	Max. data rate	Advantage	Disadvantage	Use case
IEEE 802.3	Ethernet	10/100 Mbps, 1/10 Gbps	Reliable	QoS not inherited	Fixed core connections
IEEE 1394	Firewire	400 Mbps	QoS	Multi-device performance	A/V connections
USB v.1	USB	12 Mbps	Plug'n'Play	Limited distance	PC peripherals
USB v.2 Hi-Speed		480 Mbps			
PLC, HomePlug etc.	-	100 Mbps	Uses existing electrical wiring	Interference with electrical devices	Home automation, A/V devices

3.3. MANAGEMENT SERVICES FOR DIGITAL HOMES

This chapter has described the various devices and services that are part of the digital home concept. The more devices and services there are, the more complex networking environments there will be. Most consumers are not technical experts, and therefore they find the necessary installation, configuration, and maintenance tasks overwhelming. This probably holds back the overall adoption process – if the consumers cannot turn to service providers to seek for help. The concepts *management of digital homes* and *digital*

[61] Sources: Kilpinen (2006), Porcino & Hirt (2003), Zahariadis et al. (2002)

home management are used in this thesis to address to tasks that are involved in setting up, running and maintaining the digital home (see footnote 2).

Offering digital home management as a service is in service providers' interests, not necessarily just because it creates a new opportunity to grow revenues, but particularly because it supports the service providers' core business. If the average consumer is able to put up a home network, he or she will probably want to use the new services made possible by the home network. However, it can be expensive to provide management services. Especially costly are labor-intensive services, such as running a telephone support center or sending technicians on the spot. This is why as much of the management as possible should be automated, or at least handled remotely.

There are companies that help operators automate their support and other management tasks. Motive, Inc. is used as an example here. Motive is a leading software company that provides broadband access operators with tools to assist digital home management.[62] According to the company, its software applications eliminate or speed up tasks such as self- or operator-assisted installation, service configuration, problem diagnosis and resolution, service upgrades, and remote management. Motive's key product, Home Device Manager (HDM), enables broadband operators to manage remotely customer premises equipment such as residential gateways, VoIP terminal adapters, and IP based set-top boxes.[63] Motive's customers include several U.S. and European top broadband service providers, for example BellSouth, AT&T, Verizon, AOL, BT, and Deutsche Telekom.

3.3.1. Digital Home Management Hierarchy

Several frameworks give guidelines for management of data networks and management of business processes. Here are examples of widely adopted frameworks:

- The FCAPS is a well-known framework for network management, which the International Organization for Standardization (ISO) has applied into the OSI reference model.[64] FCAPS stands for *fault, control, account, performance,* and *security*.

[62] Motive Web page: http://www.motive.com/ (Accessed December 5, 2006)
[63] Motive (2006)
[64] ISO Web page: http://www.iso.org/

- The TeleManagement Forum's eTOM framework carries out the forum's endeavor to "improve the management and operation of information and communications services." [65] eTOM presents business process guidelines for SPs and their suppliers in the telecom industry.
- The Information Technology Infrastructure Library (ITIL) is a framework for IT service business. Similar to eTOM, it presents management procedures for organizations to help them in IT operations.[66]

The abovementioned frameworks are not applicable in this thesis though, because they do not extend to the home level. For this reason, a new framework, shown in Figure 13, was developed to model the problem of managing digital homes.

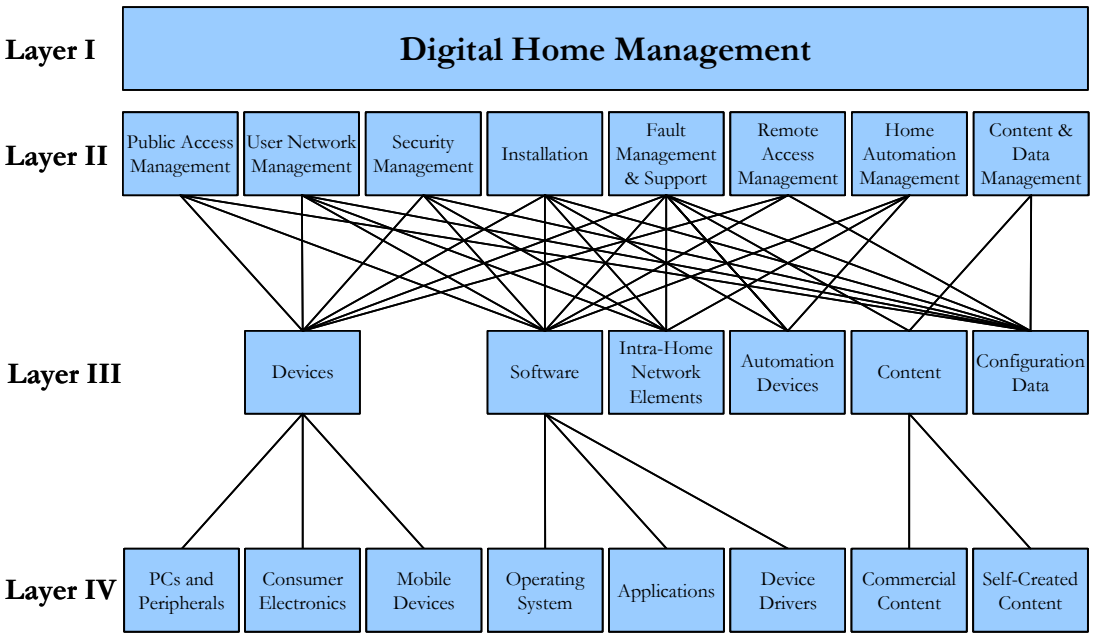

Figure 13. Management Hierarchy in Digital Homes

In the figure, management of digital homes is divided into four layers. Layer I represents the digital home management concept as a whole, and layer II shows the management entities that service providers can offer as separate services. On layer III are elements and element groups of digital home environment that need to be managed. The groups are opened up on layer IV.

[65] TM Forum Web page: http://www.tmforum.org/. eTOM stands for *enhanced Telecom Operations Map*.

[66] ITIL Forum: http://www.itilcommunity.com/, ITIL Open Guide: http://www.itlibrary.org/

The lines between layer II and layer III in Figure 13 illustrate the relationships between management entities and digital home elements. They point to the elements that are affected by each management entity. For instance, security management on layer II is connected to devices, software, intra-home network elements, and configuration data on layer III. This implies that the security manager of a home can manage hardware firewalls, software firewalls, virus scanners, intra-home network wirings, and WLAN configurations. Between layer III and layer IV, the lines point to the elements that each group consists of.

3.3.2. Management of Home vs. Management of Office

The business world has been in many cases ahead of consumers in technology adoption. For instance, e-mail and VoIP were taken into everyday use in offices before the home users adopted them. Consequently, the office environment is a potential reference to the home environment in management services. The two environments are not homogeneous though, and therefore it is not plausible to think that successful office management methods could automatically be applied to management of digital homes.

Centralized IT management is a key thing that the service providers can learn from large offices. In large companies, there are usually dedicated IT departments that take care of all the management related to employees' workstations. Software installations, security management, and software application updating can be done remotely from a corporate server. The users may have limited user rights to the workstations, which is helpful in maintaining a high security level. While this kind of a centralized model frees the user from all management tasks, it decreases the users' control and makes them dependent on the IT administrator.

Small offices understandably do not have separate IT departments; they do not necessarily even have IT administrators dedicated solely to IT management. Because of this reason, a small office is a better point of reference to a digital home than a large office is. There are differences between small offices and homes though, as is visible in Table 9 that compares small offices and homes concerning IT-related issues. Nevertheless, if outsourced IT management becomes common in small offices, the services providers should be perceptive and try to gather up hints on how to serve home users efficiently.

Table 9. Comparison of Small Offices and Homes

	Small Office	Home
Number of devices	Few	Many
Number of different kinds of devices	Few	Many
Number of users	~3-10	~1-4
Tailored applications	Common	Rare
ICT spending % of revenue	~3 %[67]	~2-3 %[68]
Owner of devices	Employer	User

3.4. Assumptions about Future Digital Homes

Because of the high level of uncertainty, it is not an easy task to analyze the future of digital home management business. To reduce the complexity and narrow down the scope of this thesis, some assumptions have to be made. The following assumptions are made on issues that are uncertain and therefore they differ from the fundamental drivers that are listed in the following chapter explaining the scenario construction process.

- **The digital home system will be formed around the PC world**. The rationale behind this assumption include, that 1) Media center PCs have already reached reasonable market penetration, 2) future applications require more PC-like performance and capabilities from devices, and 3) the Internet goes hand in hand with PCs.
- **The potential players are divided into three categories**: Operators, software platform firms, and other service firms. Media companies are left out of consideration, since they are not supposed to be able or willing to manage PC-based homes.
- **Management service provision is a critical element for the proliferation of home networking.** The amount of manual management required from the end user needs to decrease. This will set the scene for increasing number of home network implementations and will increase consumption of services.

[67] IT budget sizes of large enterprises. AMR Research data presented in Paul (2005).
[68] Spending to communications in OECD, 2000. OECD Observer (2003).

4. Scenario Construction Process

4.1. EXPERT INTERVIEWS

Interviewing industry experts was an important initial step in the scenario construction process. The purpose of the interviews was to gather state-of-the art information on home networks, and to get insight about what the critical things are that should be considered in this thesis. Initially, the intention was to get the scenario variables as a direct output from the answers. The following sections, however, explain why this was not accomplished.

The interviews were conducted between September 21 and October 24, 2006 in Helsinki, Espoo, Kirkkonummi and Tampere. There were altogether nine interviews, each done in different organizations. Table 10 shows the list of interviewed people.

Table 10. List of Interviewees

Name	Working Title	Organization
Björn Melén	Senior Research Scientist	Ericsson
Marko Väisänen	Technology Manager	Elisa Oyj
Kari T. Ojala*	Senior Adviser, Networks and Competition	Ministry of Transport and Communications
Jari Karttunen	Director, Operator Sales and Partnerships	Finnet Carrier
Jyri Puumalainen	Senior Consultant	Omnitele
Seppo Nieminen	Business Development Manager	Digita
Markus Lindqvist	Director, Watch New Systems Solutions	Nokia Multimedia
Pirkka Palomäki	Executive Vice President, R&D	F-Secure
Heikki Pentikäinen	Customer Manager	VTT

** Assisted by Mikael Åkermarck, Research Officer*

Each interview began with a short presentation that guided the discussion into home networking and explained that the focus was in digital service business.[69] Fifteen potential scenario variables, i.e. uncertainty elements about the digital home service industry, had been identified earlier. These were explained to the interviewees and then discussed one by one. These issues were discussed about the potential scenario variables:

- What will the uncertainty element look like after roughly five years? In what direction will it change, or will it perhaps stay unchangeable?

[69] The scope narrowed only after the interviews into digital home management.

- How high is the level of uncertainty about the outcome of the element?
- What are the main factors that drive the development of the variable?
- How relevant is the variable for the industry? How high an impact does it have on the future of digital service business?

A summary of the interviews with some added thoughts can be found in the Appendix.

4.2. Approach to Scenario Construction

As mentioned earlier, this thesis is focused on management services. Therefore, in the following scenarios all the other sides of operator business are left without consideration. In practice, this means that operators may continue their other business as they are currently doing, or they might for example deploy multi-play services on a large scale. However, only digital home management is discussed in this thesis. It is probable that in different management scenarios also the other business domains would be different.

The reason for choosing scenarios as the central theoretical framework of this thesis is that home networking is an emerging business area. There are no clear dominant designs for home network architecture, and it is uncertain what the killer applications will be or who will get the biggest role at homes. Home networking is full of these kinds of uncertainties, which makes scenarios exactly the right method to analyze the business environment. After all, scenario analysis was developed to help business planners cope with uncertainties.

As explained in 2.6, there are several approaches to scenario construction. The initial approach taken in this thesis was the one explained by Michael E. Porter in his book *Competitive Advantage*.[70] However, this method turned out to be too restricting for the purposes of this thesis, and therefore it was switched to another, less formal one. The following subsection briefly describes Porter's method and explains the problems encountered. Then, the logics of the method eventually used in this thesis are explained, and the construction process is described. Chapter 5 presents the resulting four scenarios.

[70] Porter (1985)

4.2.1. First Attempt: Porter's Industry Scenarios

Porter's industry scenarios framework is well structured and works in the business world where rapid decision-making is often needed.[71] According to Karlson et al, a similar method is used by large consultancies, and the method "is built on quickly identifying what's most relevant, cutting the ambiguities, and acting quickly on the relevant information."[72]

The process of applying Porter's structured method starts with identifying as many uncertainty elements as possible that relate to the industry under discussion. The ultimate goal is to find a few key drivers among these uncertainties, which will eventually be chosen as scenario variables. Requirements for the scenario variables are that they are uncertain, relevant for the future of the industry, and independent from each other. To identify the variables, the listed uncertainty elements are first rated by importance, and those that turn out to be irrelevant are dropped from the analysis. Then, dependencies between remaining elements are identified, and those elements that are dependent and closely correlated are merged if possible. These steps are iterated until only a few and most important elements are left. These will then form the scenario dimensions and are called scenario variables. In the ideal case, there are two scenario variables both having two possible outcomes. The scenario space can then be illustrated using a 2 x 2 matrix, and the four scenarios are formulated to fit into the four cells of this matrix. Adding more possible outcomes to the variables rapidly increases the number of scenarios. For example, if either one of the variables has three possible outcomes, the scenario space will be illustrated by a 3 x 2 matrix, resulting in six scenarios.

The abovementioned method was first chosen for this thesis, and the process was actually taken quite far. Uncertainty elements were first listed and categorized based on Porter's five forces of competition framework explained in 2.4. Candidates for scenario variables were then discussed with industry experts, and several draft matrices were developed. However, even after thorough considerations and several iterations of dropping less important elements, no two or three outstandingly important elements could be found that could also be considered independent. The remaining elements were all considered relevant, and between them was a complex web of interrelationships. Since

[71] Porter (1985)

[72] Karlson et al (2003)

the intention was such that no dimension that is potentially important would be ignored, there were two alternatives. The first one was to break down the scenario analysis into several smaller analyses focusing on detailed business cases. This would have resulted in several 2 x 2 matrices, and each would have been analyzed separately. The other choice was to start over the whole process using a less restricting framework. The latter was considered a better choice, because it enabled doing a more coherent work.

4.2.2. New Approach: Trend-Based Scenario Construction

While struggling with the problems explained above, an alternative approach to scenario construction was found in the book Wireless foresight: scenarios of the mobile world in 2015.[73] This approach builds on identifying dominant trends in the environment, and assigning different weightings to them to create distinct scenarios. There are predetermined trends and uncertain trends. Predetermined trends are called fundamental drivers or mega-trends, and they are common to all scenarios and assumed valid for the five-year period chosen for the scenarios. The uncertain trends, i.e. trends whose direction and rate of change is uncertain, make the scenarios different from each other.

The uncertain trends used in this method correspond to the scenario variables of the Porter's structured method. However, there are two fundamental differences between the methods. Firstly, the trends need not be mutually independent, and secondly, more dimensions can be included since there is no need to express the scenarios by a two-dimensional matrix. The fundamental drivers and trends created for this thesis are explained below.

4.3. THE INITIAL SETTING IN 2007

In the spring of 2007, a fictitious Finnish broadband access operator was pondering on its strategic moves in the provision of services to digital homes. Home networking was a hot topic in trade journals of telecom, consumer electronics, and computing industries. The common belief was that masses of consumers would in the near future equip their homes with digital devices that were connected to each other and to the Internet, enabling provision of new services over the line. There was a lot of uncertainty involved, though. Despite the high hopes, it was not actually known what services, if any, would

[73] Karlson et al (2003)

eventually bring the mass profits. The common guess was that the killer applications would be born around digital entertainment.

The operator had studied the business environment thoroughly, and concluded that it was not yet smart to invest on infrastructure and contracts that would enable provision of entertainment services. Instead, the operator concluded that it should study more the management side of home networks. The reasons for this were the following:

- Management services are a potential revenue source.
- Management services create ways to differentiate from other operators.
- If management services are widely available to consumers, the threshold to acquire home networks could decrease, thus speeding up the market growth.
- The player who manages digital homes has more control over home users than other service providers do. It is potentially easy for the player who manages a digital home to provide other services into that home, too.

The scenario analysis conducted in this chapter could be thought as additional research made by the fictitious operator by itself, or by a consulting firm. The purpose of the analysis would in this case be to answer questions about the future of management services in home networking, such as: What is needed for digital home management to grow into a large business? What does the business environment look like if people are not willing to pay for management? Who are the potential players in the future? What is the role of an operator in each scenario?

4.4. FUNDAMENTAL DRIVERS

Before constructing the digital home scenarios, the fundamental drivers or mega-trends need to be explained. These drivers are underlying all scenarios and they are assumed valid at least for the next five years with a reasonable probability. In other words, if a trend seems certain, no matter what scenario realizes, then it is a fundamental driver. The fundamental drivers can be put into four categories: 1) technology, 2) socioeconomic and political, 3) business and industry, and 4) users, values and attitudes. The following list is mostly adopted from Wireless foresight: scenarios of the mobile world in 2015, a book that presents four scenarios for the wireless communications industry.[74] Since the drivers

[74] Karlson et al (2003)

listed in the book are fundamental by nature and defined quite vaguely, they can be used in other contexts as well, such as home networking. While some drivers from the original list are left out, a couple of new ones are added and the explanations of the original drivers are rewritten to reflect the understanding accumulated in conducting this thesis. Some fundamental drivers do not appear in the lists in section 4.5, because they cannot be assigned directly to any particular trend. They are important, however, and present in each scenario. Some of the drivers can be theoretically justified and some are based on common knowledge and current trends. Explanations that are more detailed can be found in the Wireless foresight book.

4.4.1. Technology Drivers

- **Complexity of home networks will increase.** The number of services offered to home users and the number of networked home devices will increase, making the home environment difficult to manage.
- **Amount of digital content will increase**. The volume of content that is stored and handled at home will increase. This includes self-created content such as photos, video clips and text documents, and commercial content bought from online stores or ripped from CDs or DVDs.
- **Broadband penetration and capacity will increase**. More households will subscribe to a broadband Internet access. Data rates will continue to grow, and at the same time, cost per transferred bit will decrease. Twisted copper and coaxial cable will remain dominant media for the customer end connectivity for the next five years, although new houses will often be equipped with optical fiber.[75]
- **Capacity of wireless WANs will increase but will not reach the capacity of fixed WANs.** Wireless technologies are approaching the upper limit of spectral efficiency as stated by Shannon's law. Availability of new spectrum is also limited. As a result, cell sizes need to be decreased to keep capacity growing.
- **Access networks will remain slower than intra-home networks**. Short wirings and small cell sizes in intra-home networks enable high capacities. As a result, access network connections will remain bottlenecks.

[75] Expert interviews conducted between September 21 and October 24, 2006.

- **Digitalization will increase.** The trend of moving from analog to digital will continue. One milestone is the abolition of analog television broadcasts. In Finland, this is scheduled to take place in 2007.[76]
- **Internet development will be dominating.** Technological development is heading towards all-IP networks where all services are based on Internet Protocol.
- **Battery capacity will increase slowly.** Slow development of batteries forms a bottleneck in adding more power-consuming capabilities into wireless devices.
- **Processing power will increase exponentially**. Moore's Law states that processor capacity doubles every 18 months. This is expected to stay valid for the next five years.
- **Memory capacity will increase exponentially**. As memory capacity increases, the cost per bit stored in memory decreases.
- **Optical network capacity will increase exponentially**. Fiber-based backbone network capacity will continue to increase. Fiber will also grow its importance as a transfer medium in access networks in relation to copper wire and coaxial cable.

4.4.2. Socioeconomic and Political Drivers

- **The problem with e-mail spam, viruses, intrusions, and malware will not disappear**. There are no signs that any of these harms would get fully under control in the near future.
- **Globalization will continue**. Decreasing costs of transportation and communication will promote global trade and movement of people and ideas. Foreign companies are able to offer the same services as local companies on equal basis.
- **Fighting against terrorism and crime, particularly cybercrime will continue**. Governments will increase cooperation in order to be able to respond to security threats.
- **Shift towards knowledge economy and services**. Services and knowledge are the main economic drivers in developed countries, while manufacturing has moved into developing countries. Newly Industrialized Countries (NIC), such as China and India are building their knowledge economies as well.

[76] Ministry of Transport and Communications Finland (2006)

- **Population will continue to age in developed countries**. Lengthening life expectancies and falling birth rates result in the older segment of the population to keep growing.

4.4.3. Business and Industry Drivers

- **Companies will become more service-oriented**. Selling physical goods switches into providing services. Companies strive for this because it locks customers in for predetermined periods. Existing evidence for this mega-trend are operators' device leasing offerings.
- **Market uncertainty around home networks will decrease**. Because home networks are currently in emerging phase, the uncertainty is high. According to Mark Gaynor, market uncertainty of network-based services tends to decrease over time.[77] Triggers for this reduction include clarified end user needs, maturing technologies, and resolved regulatory tugs-of-war. However, there will be new uncertainty elements, such as disruptive technologies, that can temporarily increase market uncertainty.
- **Value networks will increase in complexity**. More complex value network relations will replace the linear value chains. There will be more room for specialized business models, which means that management of complex external relationships gets attention.
- **Companies strive towards market dominance**. Despite the proliferation of open platforms and standards, companies continue to lock their customers in and competitors out, in other words to create temporary monopolies.
- **Economies of scope will attract companies to aggregate their offerings**. Economies of scope refer to efficiencies achieved when several different types of products are offered by the same company. Such efficiencies arise for example from using a single brand name for the marketing of several offerings, or from using the same distribution chain for several products.
- **Economies of scale will increase the efficiency of large service providers**. Economies of scale mean that firms are able to operate more efficiently when they produce large volumes of products of services.

[77] Gaynor (2001)

- **There will be new entrants on the digital home service market**. Growth potential attracts new players to enter the market. The result is that competition increases and eventually profitability decreases.

4.4.4. Users, Values, and Attitude Drivers

- **Increased technology adoption in everyday life**. New devices are taken into everyday use. The learning curve states that users become more efficient in performing new tasks or using new devices as they gain experience on them.
- **Values change at the pace of generations**. Consumers acquire their fundamental values when they are young, and these values are hard to change. Overall value shifts in society happen mainly through generational change and are thus slow by nature.
- **Importance of family and friends will stay high**. Forming social networks with family, friends, and other groups is considered important.
- **Need for mobility and communication will increase**. Mobile lifestyle increases the need to communicate and the need to have personal mobile devices.
- **Environmentalism and health concerns will increase**. Feeling responsible for the environment increases. Health risks get more attention.

4.5. TRENDS WITH UNCERTAINTY

This section describes the trends that are used in developing the scenarios. They are identified based on the fundamental drivers and knowledge accumulated in the market research and expert interviews. The direction and impact of these trends are uncertain. After each description follows a figure that shows the weight that the trend in question is given in the four scenarios, and a list of the fundamental drivers that are most important influencers of the trend.

4.5.1. Trend 1 – Outsourcing Digital Home Management Tasks Will Become More Common

As the digital home grows into an ever more complex system, technologically incapable people have no other choice but to start using outside help with management tasks. Otherwise, home networks will remain a thing for tech-enthusiasts who are able and willing to manage the digital home by themselves, and the overall digital service business

will grow slowly. This trend is broader than most of the other trends chosen for scenario dimensions. It correlates strongly with user's trust, consumption habits, service aggregation, and regulatory intervention. Figure 14 shows the weightings that the trend is assigned in the scenarios. The five spheres on the scale illustrate the range of possible ranks. A black sphere means that the trend is used in one or more scenarios with the corresponding rank. The digits 1 to 4 below the black spheres indicate scenarios. For example, the rightmost black sphere with a digit 1 below it means that in scenario 1, this trend has been assigned the right extreme value. This can be verified by taking a look at Figure 22 that shows all the trends and their weightings in scenario 1.

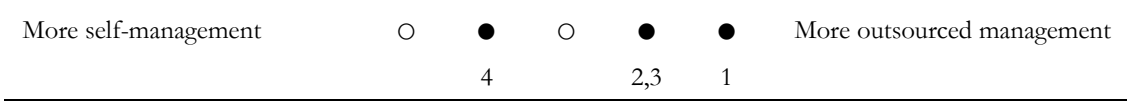

Figure 14. Weight of Trend 1 in Scenarios

FUNDAMENTAL DRIVERS

- Broadband penetration and capacity will increase
- Digitalization will increase
- Complexity of home networks will increase
- The problem with e-mail spam, viruses, intrusions, and malware will not disappear
- Amount of digital content will increase
- Shift towards knowledge economy and services
- Companies will become more service-oriented
- Population will continue to age in developed countries

4.5.2. Trend 2 – Digital Home Management Will Be Offered in a Centralized Manner

Market uncertainty tends to decrease over time, as technologies mature and dominant designs emerge. According to the uncertainty theory explained in section 2.2, decreasing market uncertainty results in a greater probability for centralized management structures.

The degree of centralization is measured here with the location where the management tasks take place. On the axis shown below, distributed management extreme means that the tasks are done at home by the user (i.e. self-managed) or by a person who visits the

customer premises. The centralized management extreme on the other hand means that file backups, configuration data etc. are stored in global servers that are managed by giant corporations who manage homes all over the world. In the center of the axis, a company that resides reasonably close to the user, for example an access operator, takes care of the management. No single weightings can be put on this trend in scenario 3, because there are various diversified players on market in that scenario. In scenario 4, digital home management is offered both in a distributed and in a centralized manner (Figure 15).

Distributed management	●	○	●	○	●	Centralized management
	4		1		2,4	

Figure 15. Weight of Trend 2 in Scenarios

FUNDAMENTAL DRIVERS

- Broadband penetration and capacity will increase
- Internet development will be dominating
- Complexity of home networks will increase
- Companies will become more service-oriented
- Market uncertainty around home networks will decrease

4.5.3. Trend 3 – Fight for Digital Home Services Will Intensify

Companies from various industries are competing about providing similar services to homes, and the rivalry seems to be intensifying. All-IP environment allows practically any company to provide for example telephony over Internet, and with IP based television, broadcasting companies face competition for example from operators. Similar rivalry is assumed to happen in digital home management, and it is not at all clear who will emerge as a winner. Potential players are divided into three categories: operators, software platform firms such as Microsoft and Apple, and other IT firms. The last category includes companies who are specialized in digital home management, and for example Google or Yahoo-like service firms, who could launch certain digital home management services such as network backups (Figure 16).

Operators weak	●	●	●	○	●	Operators strong
	2	4	3		1	
Software platform firms weak	○	●	●	○	●	Software platform firms strong
		1,4	3		2	
Other service providers weak	●	●	●	○	○	Other service providers strong
	2	1,4	3			

Figure 16. Weight of Trend 3 in Scenarios

FUNDAMENTAL DRIVERS

- Internet development will be dominating
- Globalization will continue
- Companies strive towards market dominance
- There will be new entrants on the digital home service market
- Value networks will increase in complexity
- Economies of scope will attract companies to aggregate their offerings
- Economies of scale will increase the efficiency of large service providers

4.5.4. Trend 4 – Users' Trust over Firms Will Change

Trust over firms is an important force, because it affects users' willingness to hand out critical information to firms. Examples of critical information are identities, passwords, and personal photos and videos. Even though family photos are unique and thus important to backup, no firm can run a backup service for them if the family only keeps them safe on the hard drive of the home computer. Trust over firms is not a black-and-white issue but it has flavors. Users may for example have more confidence in national firms than global firms (Figure 17).

Low level of trust	●	○	●	●	●	High level of trust
	4		1	3	2	

Figure 17. Weight of Trend 4 in Scenarios

FUNDAMENTAL DRIVERS

- Globalization will continue
- Fighting against terrorism and crime, particularly cybercrime will continue

- The problem with e-mail spam, viruses, intrusions, and malware will not disappear
- Values change at the pace of generations
- Environmentalism and health concerns will increase

4.5.5. Trend 5 – Market Concentration in the Digital Home Industry Will Change

The future structure of the digital service industry is unknown. It is possible that few large actors having strong market power will dominate the industry, but also fragmentation may happen so that market power is distributed to a large number of smaller actors. This trend is not applicable in scenario 4 (Figure 18).

Many actors	●	●	○	○	●	Few large actors
	3	1			2	

Figure 18. Weight of Trend 5 in Scenarios

FUNDAMENTAL DRIVERS

- Globalization will continue
- Companies strive towards market dominance
- There will be new entrants on the digital home service market
- Value networks will increase in complexity
- Economies of scope will attract companies to aggregate their offerings
- Economies of scale will increase the efficiency of large service providers

4.5.6. Trend 6 – Consumption Habits Will Change

Consumers are changing their consumption habits from fixed investments to monthly or weekly payments. In other words, the desire to own things gets less important. Sales of equipment is chosen to be the variable representing this trend, because it potentially has remarkable influence on digital home management. It seems sensible that the party who owns the equipment, i.e. the one who leases it out, manages it. This conclusion gets

support from the industry experts, who pointed that ownership and management role are dependent from each other.[78]

A spark for this change in consumers' mindsets could be the fact that state-of-the-art devices are expensive, but they lose their value quickly, and might become obsolete if a more advanced technology emerges. Although it is unknown how fast this shift is happening, there are signs showing that it has already begun. Broadband operators have started to offer digital home equipment leases, and mobile handset bundle offerings have proved to be popular (Figure 19).

More purchased equipment	●	○	●	○	●	More leased equipment
	4		2,3		1	

Figure 19. Weight of Trend 6 in Scenarios

FUNDAMENTAL DRIVERS

- Digitalization will increase
- Internet development will be dominating
- Complexity of home networks will increase
- Shift towards knowledge economy and services
- Increased technology adoption in everyday life

4.5.7. Trend 7 – Service Aggregation Will Become More Common

Closely related to the previous trend, service aggregation plays an important role in the scenarios. Rental devices are often bundled with other offerings. Mobile handsets can be bundled with mobile subscription, and digital home devices can be bundled with broadband Internet subscription. Players that are able to offer attractive bundles will be strong in this scene. It might turn out that consumers are not willing to pay for management services in the raw; they would need to be hidden within broader service bundles (Figure 20).

Less bundles	○	●	○	○	●	More bundles
		3,4			1,2	

Figure 20. Weight of Trend 7 in Scenarios

[78] Expert interviews conducted between September 21 and October 24, 2006.

FUNDAMENTAL DRIVERS

- Broadband penetration and capacity will increase
- Internet development will be dominating
- Companies will become more service-oriented
- Companies strive towards market dominance
- Value networks will increase in complexity
- Economies of scope will attract companies to aggregate their offerings
- Economies of scale will increase the efficiency of large service providers

4.5.8. Trend 8 – Regulatory Intervention Will Increase

Regulatory authorities have interfered in various domains of digital service business. Regulations do not only affect allocations and licensing of wireless frequencies but they promote healthy competition in telecom and software industries. Local loop unbundling (LLU) is evidence of restricting local monopolies, whereas the EU versus Microsoft clauses act as evidence of restricting global monopolies.[79]

This trend is important in dictating which way the market will develop. Because particularly operator business is studied in this thesis, attention is paid here to the effect of regulation on operators' business in digital home management services. Details are left out from the chosen axis, and it shows only how favorable or unfavorable regulation is for operators. An authority could justify operator-favorable regulations for example for one or more of the following reasons:

- Maintaining national self-control, i.e. protecting domestic businesses
- Ensuring legal interception. The official authorities must be able to access personal data for example when doing criminal investigation.
- Forcing security in Internet connections. The regulator could fight against viruses and other such threats by coercing operators to provide only secure connections (Figure 21).[80]

[79] Marcus (2005)

[80] In France operators are already obliged to offer parental control service with an Internet connection without charging for it separately. European Digital Rights, see: http://www.edri.org/book/print/858 (Accessed December 29, 2006).

Unfavorable for operators	●	○	●	○	●	Favorable for operators
	2		3,4		1	

Figure 21. Weight of Trend 8 in Scenarios

FUNDAMENTAL DRIVERS

- Globalization will continue
- Fighting against terrorism and crime, particularly cybercrime will continue
- The problem with e-mail spam, viruses, intrusions, and malware will not disappear
- Companies strive towards market dominance
- Environmentalism and health concerns will increase

5. Management Scenarios

In this chapter, four scenarios for digital home management services are developed. They are based on the fundamental drivers and uncertain trends identified in chapter 4, and the descriptions are written out keeping in mind that this thesis is focused on operator business. Key characteristics of the scenarios are summarized in Table 11.

Table 11. Summary of Scenarios

Scenario 1 *Locally Centralized*	**Scenario 2** *Globally Centralized*	**Scenario 3** *Global Specialists & Local Janitors*	**Scenario 4** *Do-It-Yourself*
Comprehensive management services are available	Some self-management required	Comprehensive management services are available	Only software updates are automated, everything else is self-managed
Operators dominate	Software platform firms dominate	Many specialized players with equal power	Firms have little control over homes
Management bundled with broadband subscription	Management integrated into operating system	Separate management services offered by different service providers	Update service included in software applications, otherwise self-management
Critical data stored in operator's network	Critical data stored in software platform firm's network	Critical data kept at home or stored in trusted service provider's network	Critical data kept at home
Strong equipment leasing dominated by operators	Moderate amount of equipment leasing	Moderate amount of equipment leasing	Little equipment leasing

5.1. SCENARIO 1: LOCALLY CENTRALIZED

Figure 22 lists the trends that define the scenario space, and shows the values the trends have been given in this scenario.

Outsourcing digital home management tasks will become more common						
More self-management	○	○	○	○	●	More outsourced management
Digital home management will be offered in a centralized manner						
Distributed management	○	○	●	○	○	Centralized management
Fight for digital home services will intensify						
Operators weak	○	○	○	○	●	Operators strong
Software platform firms weak	○	●	○	○	○	Software platform firms strong
Other service providers weak	○	●	○	○	○	Other service providers strong
Users' trust over firms will change						
Low level of trust	○	○	●	○	○	High level of trust
Market concentration in the digital home industry will change						
Many actors	○	●	○	○	○	Few large actors
Consumption habits will change						
More purchased equipment	○	○	○	○	●	More leased equipment
Service aggregation will become more common						
Less bundles	○	○	○	○	●	More bundles
Regulatory intervention will increase						
Unfavorable for operators	○	○	○	○	●	Favorable for operators

Figure 22. Trend Weightings in Scenario 1

5.1.1. Overview of the Scenario

In this scenario, management of digital homes is a large business dominated by broadband operators. Consumers have some reservations about handing over critical data to companies, but local operators have managed to develop trustful customer relationships over time. The role of an operator resembles the role of today's corporate IT administrator but on a larger scale: instead of managing individual computers within a corporation, the operator serves complete digital home systems within its area of operation.

The management structure of operator-provided services is locally centralized. It means that the operator has pulled parts of the home network intelligence into its own network. The operator runs large servers that maintain real-time backups of user files and configuration data, and acts as an application update aggregator. It also takes care of firewalls and other security issues.

Figure 23 illustrates the locally centralized scenario.

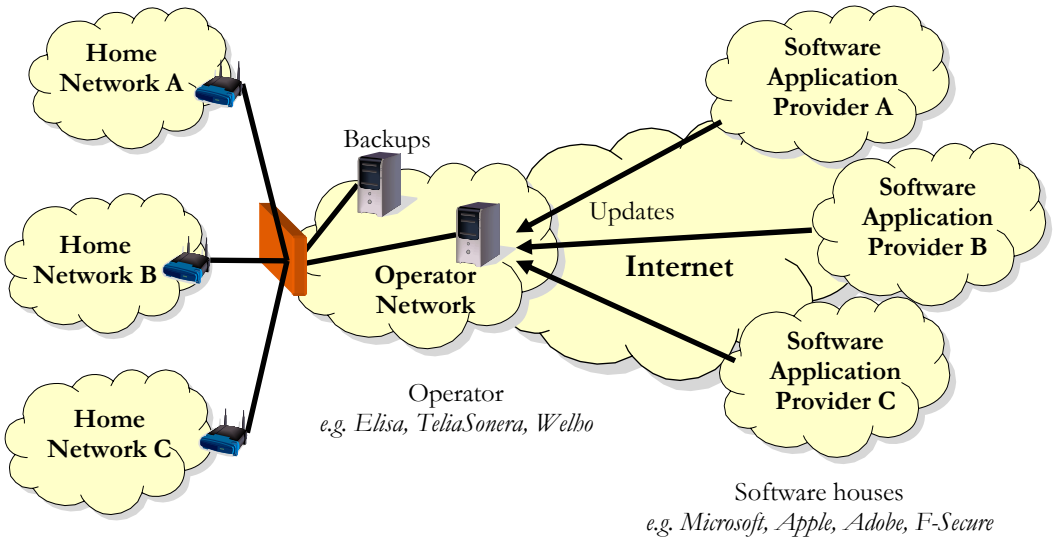

Figure 23. Locally Centralized Management

Operators offer various kinds of service bundles to match customer needs. Many users subscribe to all-inclusive service bundles that include Internet access, leased hardware devices, and a full management service. Only people who are enthusiastic about technology buy their own devices and handle management tasks by themselves. It is notable that the operators' strength in these offerings makes them probable providers of content and value added services as well, although these are outside the scope of this thesis.

5.1.2. Evolution from 2007 to 2012

Ever growing complexity of digital homes and increased network security threats forced consumers to change their behavior. The average home users realized that they could no longer take care of their digital home systems by themselves, so they began to trust in service firms to handle management. The obvious choice for many consumers was the local broadband operators, with whom they already had business relationships. If the operators had been performing well in providing Internet connectivity, it was easier for consumers to trust them, giving the operators advantage over global service providers, for example. What is more, most operators had already been offering certain management tasks for an additional fee on top of Internet access, including firewall, virus software, and spam filtering.

At the same time, operators went more and more into hardware business. They sold digital home device leasing contracts, which tied customers tightly to their operators. It

was natural to aggregate management services with the lease, because the equipment remained under operators' ownership. Eventually, operators started to offer all-inclusive services, where Internet connectivity, hardware devices, essential software applications, and management were offered for a fixed monthly price.

5.2. SCENARIO 2: GLOBALLY CENTRALIZED

Figure 24 lists the trends that define the scenario space, and shows the values the trends have been given in this scenario.

Outsourcing digital home management tasks will become more common						
More self-management	○	○	○	●	○	More outsourced management
Digital home management will be offered in a centralized manner						
Distributed management	○	○	○	○	●	Centralized management
Fight for digital home services will intensify						
Operators weak	○	●	○	○	○	Operators strong
Software platform firms weak	○	○	○	○	●	Software platform firms strong
Other service providers weak	○	●	○	○	○	Other service providers strong
Users' trust over firms will change						
Low level of trust	○	○	○	○	●	High level of trust
Market concentration in the digital home industry will change						
Many actors	○	○	○	○	●	Few large actors
Consumption habits will change						
More purchased equipment	○	○	●	○	○	More leased equipment
Service aggregation will become more common						
Less bundles	○	○	○	○	●	More bundles
Regulatory intervention will increase						
Unfavorable for operators	●	○	○	○	○	Favorable for operators

Figure 24. Trend Weightings in Scenario 2

5.2.1. Overview of the Scenario

Large global companies dominate the digital home service business in this scenario. Since the fundamental assumption is that PC-based home networks become dominant, the firms that provide essential PC functionalities to homes are strong. Such companies are called here software platform firms, although they might also provide other software applications and hardware devices as well. Examples of current firms falling into this category are Microsoft, Apple, and large Linux distribution companies.

Homes are divided into a few different categories based on what operating system and user interface they use. Homes are perceived as "Windows homes", "Apple homes," and "Linux homes". Dumb devices such as televisions, monitors, printers, and speakers work naturally with any operating system, and intelligent devices such as MP3 players and mobile handsets are built to be interoperable with all systems.[81]

The software platform firms take care of managing digital homes. Security, software application updates, and configuration are automated and integrated to the operating system. The management structure is globally centralized, since home terminals communicate with massive servers that serve large numbers of customers. Management resembles the Microsoft Update service: the user can decide whether communication with the management servers is fully automated, semi-automated, or initiated by the user. This structure is efficient but does not enable individualistic management. Consumers either have to solve problems by themselves with the help of online support, or contact a local management service company. It is possible that the global players act as update aggregators, so that independent software application providers upload their updates to the software platform firms' management centers, which then distribute the updates along with their own updates. Emergence of an update aggregator slightly simplifies the user role, because he or she only needs to set firewalls to let devices and applications access one update site.

There is intelligence both in the global servers and in the end user terminals: software firewalls and virus protection software are installed into the computers and managed remotely, and backups of user data are kept in global servers. There are no intermediaries between the managers and homes. The service architecture of this scenario is illustrated in Figure 25.

[81] Interoperability of different content formats and DRM solutions are outside the scope of this thesis.

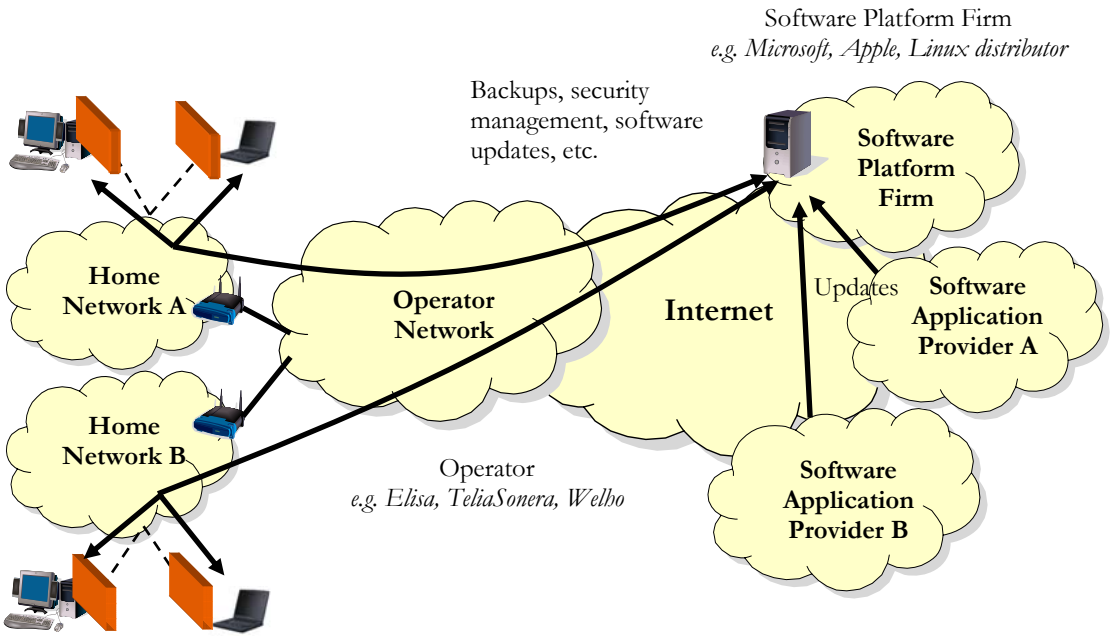

Figure 25. Globally Centralized Management

Operators are minimally involved in digital home management. Global companies outperform them because of their better operational efficiency, and operators' possible role is narrowed into individual problem solving and on-site configuration. Users expect though that everything is included in the software platform, so they are not willing to pay extra for other management. If equipment leasing takes off, operators are potential hardware providers, because they can aggregate hardware with Internet access and have the possibility to send maintenance people to set up the home network. Otherwise, operators are in the danger of becoming pure bit-pipes, providing consumers merely the connectivity to the public network with a fixed monthly fee.

5.2.2. Evolution from 2007 to 2012

Because the fragmentariness of digital home systems was hindering the penetration of home networks and thus the development of services, regulatory authorities decided not to restrict global players that had started to expand into digital home management. Software platform firms acquired security companies and other management specialists or developed their own solutions. As global companies concentrated more on security issues, users' trust over them began to increase.

5.3. SCENARIO 3: GLOBAL SPECIALISTS & LOCAL JANITORS

The weightings of the trends that define this scenario are presented in Figure 26.

Outsourcing digital home management tasks will become more common						
More self-management	○	○	○	●	○	More outsourced management
Digital home management will be offered in a centralized manner						
Distributed management	○	○	×	○	○	Centralized management
Fight for digital home services will intensify						
Operators weak	○	○	●	○	○	Operators strong
Software platform firms weak	○	○	●	○	○	Software platform firms strong
Other service providers weak	○	○	●	○	○	Other service providers strong
Users' trust over firms will change						
Low level of trust	○	○	○	●	○	High level of trust
Market concentration in the digital home industry will change						
Many actors	●	○	○	○	○	Few large actors
Consumption habits will change						
More purchased equipment	○	○	●	○	○	More leased equipment
Service aggregation will become more common						
Less bundles	○	●	○	○	○	More bundles
Regulatory intervention will increase						
Unfavorable for operators	○	○	●	○	○	Favorable for operators
× = The management structure varies greatly, since there are diverse players on market.						

Figure 26. Trend Weightings in Scenario 3

5.3.1. Overview of the Scenario

In this scenario, there are numerous players involved in management provision. In contrast to the two previous scenarios, there is no dominant player offering a broad integrated management solution. Instead, the service providers are specialized into certain management tasks. Companies handle management tasks in their own ways, so there is no uniform management structure in the industry. There are flavors from distributed, locally centralized, and globally centralized structures. Examples of players categorized by management structure include:

- Distributed: Small IT janitor companies offer on-site configuration and problem solving. Operators are also possible IT janitors.
- Locally centralized: Operators offer for example automated backup or remote configuration services. User data is in these cases stored in the operators' servers.
- Globally centralized: Software application companies and software platform firms run global servers from which end user terminals obtain application updates with no intermediaries.

This scenario resembles the current situation with the exceptions that management services are more developed and more widely available, and users are ready to pay for management. This has resulted in a substantial overall growth of the home networking business. Figure 27 illustrates the diversity of management service provision in this scenario. The roles in the figure are only examples.

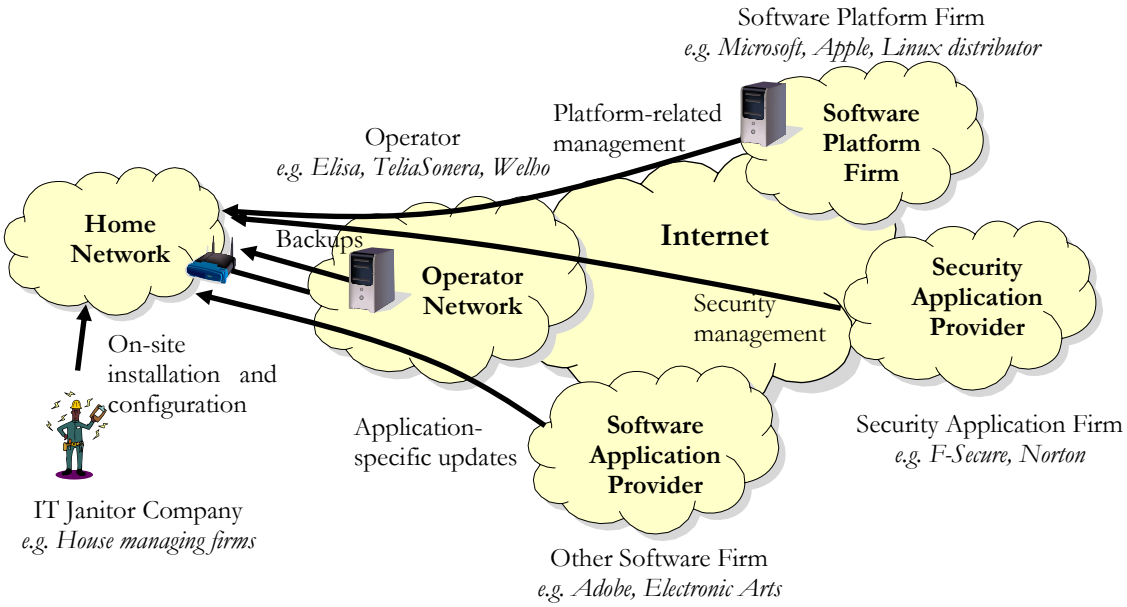

Figure 27. Diversified Management

5.3.2. Evolution from 2007 to 2012

The most explicit differences between scenario 3 and the situation of today are that home networks have been widely adopted in the scenario, and their management is outsourced to companies rather than done by consumers themselves. The story of development could go as follows.

In 2007, regulators and governments figured that home networking would not grow into the desired direction without wide availability of on-site configuration and maintenance help. Even though most software applications, including security applications and operating systems, had automatic updating systems that reduced the number of manual management tasks at home, there were still tasks that a great deal of consumers were unable to handle. The bottleneck was the initial installation of hardware, software and networks, and especially the initial configuration that made everything work. These had to be done at home, but because sending a person to set up a digital home was expensive, and consumers were not willing to pay much, few companies had entered the business.

The solution was to subsidize companies that provided these services. Subsidies made it possible to lower the prices, and slowly consumer mindsets turned more open to these services. Specialized IT janitor firms emerged, and operators entered the business. Operators that provided rental equipment commonly aggregated on-site installation and configuration to the connectivity contract. Slowly the market began to grow.

5.4. SCENARIO 4: DO-IT-YOURSELF

Figure 28 presents the weightings of the trends defining this scenario.

Outsourcing digital home management tasks will become more common						
More self-management	○	●	○	○	○	More outsourced management
Digital home management will be offered in a centralized manner*						
Distributed management	●	○	○	○	●	Centralized management
Fight for digital home services will intensify						
Operators weak	○	●	○	○	○	Operators strong
Software platform firms weak	○	●	○	○	○	Software platform firms strong
Other service providers weak	○	●	○	○	○	Other service providers strong
Users' trust over firms will change						
Low level of trust	●	○	○	○	○	High level of trust
Market concentration in the digital home industry will change						
Many actors	○	○	×	○	○	Few large actors
Consumption habits will change						
More purchased equipment	●	○	○	○	○	More leased equipment
Service aggregation will become more common						
Less bundles	○	●	○	○	○	More bundles
Regulatory intervention will increase						
Unfavorable for operators	○	○	●	○	○	Favorable for operators

* = The management structure has both extremely distributed and extremely centralized flavors.

× = Not applicable in this scenario.

Figure 28. Trend Weightings in Scenario 4

5.4.1. Overview of the Scenario

This scenario is close to the current situation. Users do not really buy management services except for fundamental security services that are usually aggregated with a broadband subscription. Software applications retrieve updates automatically or the user retrieves them, and helpful standards like UPnP have decreased the need for manual configuration. Still, the end user does the initial installation and configuration of devices,

Nordlund, Timo. 2007. Master's Thesis. Helsinki University of Technology. Department of Electrical and Communications Engineering. Networking Laboratory.

firewalls, and networks. This is the bottleneck for the spread of home networking, because only a limited proportion of consumers are able to handle these tasks.

The management structure is divided into two elements. The self-managed part is extremely distributed, since the management is distributed to all individual users. Conversely, automatic software application updates represent extreme centralization, because updates are retrieved from global servers. The structure is flexible in the sense that users can build exactly the kinds of systems they like, but on the negative side is the need for manual control. Figure 29 illustrates the management structure in this scenario.

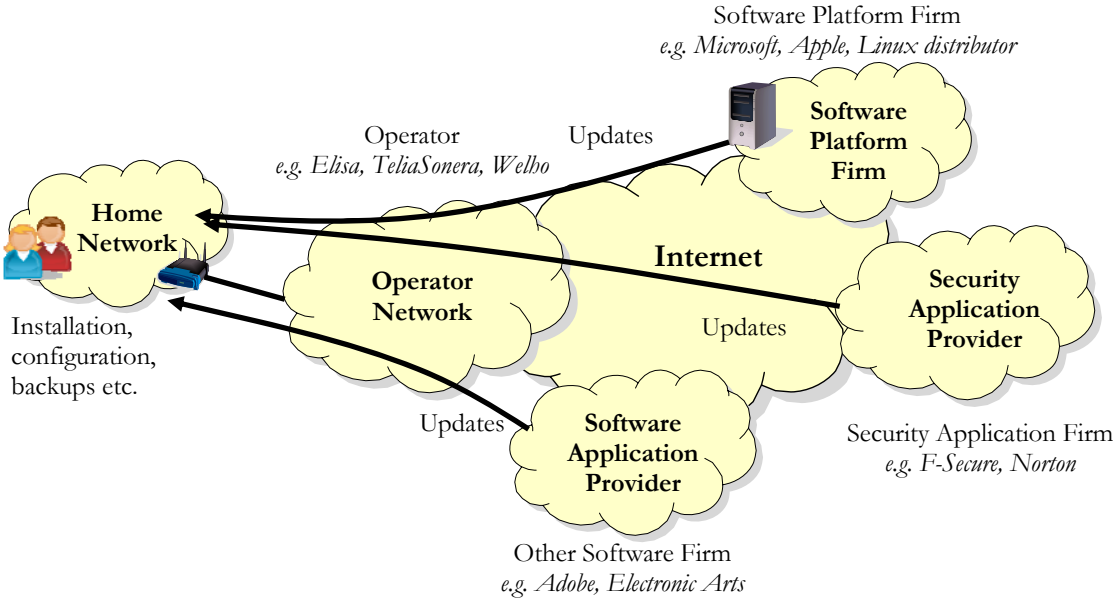

Figure 29. Do-It-Yourself Management with Global Updates

5.4.2. Evolution from 2007 to 2012

Not much has changed during this time, even though technologies have developed and made some tasks easier. Possible reasons for this include that users lack trust into companies and are reluctant to pay for management, and resulting from these, service providers do not have comprehensive management offerings.

6. Operator Business Models

This chapter describes examples of business models that operators can use in the scenarios developed for this thesis. Again, the focus is in management of digital homes and services related to it. Services like content provision and home automation are deliberately left out of discussion. Connectivity provision and customer premises equipment distribution are included though, since they are closely related to digital home management. To provide an understanding of the role of an operator in relation to other service providers and hardware providers, a simplified value net model is first explained.

6.1. DIGITAL HOME VALUE NET

The value network model depicted in Figure 30 is based on Timo Smura's mobile value network model. [82] It is modified for the purpose of this thesis. Mobile-specific terms have been replaced with more general ones, and the idea of a customer value chain is added to the model. The model utilizes the ideas of value chains described in 2.3 and value nets described in 2.5.

The chief idea shown in the figure is that applications and content, devices, and networks complement each other in order to create complete service offerings to the end users. None of the value chains alone would provide value to a user. For instance, a PC delivered through the device value chain would be worthless to the user, if no compatible applications were available. Similarly, an Internet connection is only valuable if there are devices that are able to utilize the connection.

The arrow-shaped elements in Figure 30 represent business roles rather than individual firms. A single player may take several roles. For example, the Finnish operator Elisa is a network operator, a service operator, a device retailer, and a content aggregator, operating both in mobile and fixed domains. Nokia has taken the roles of a device vendor and a network vendor in the mobile domain. Therefore, it supplies Elisa with mobile handsets and mobile networks.

[82] Smura (2006)

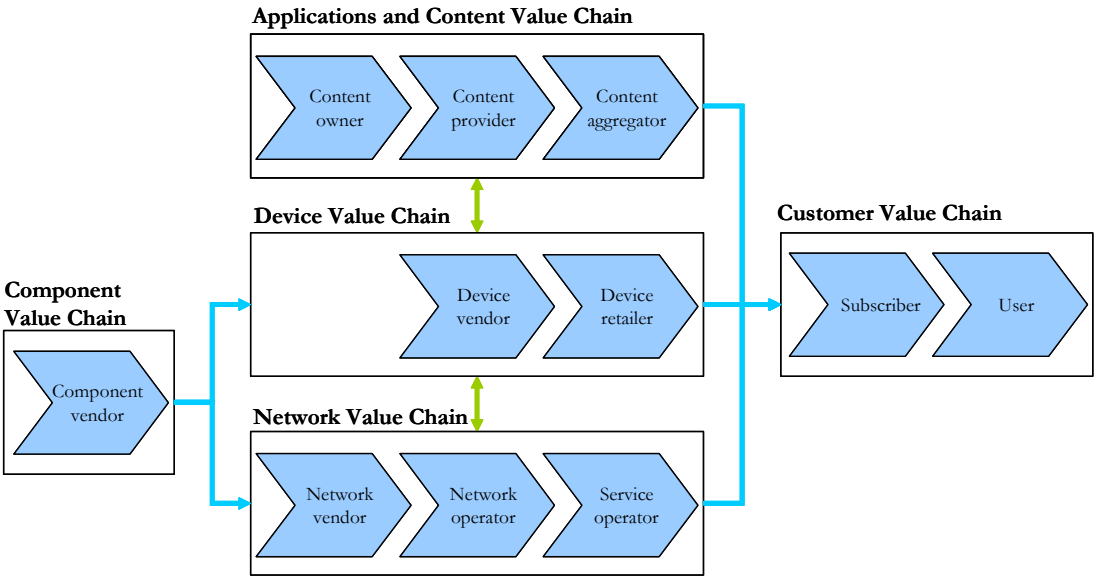

Figure 30. Digital Home Value Net[83]

While the model stresses complementarities, it does not address to competition. Competition is considered to take place between players taking similar roles. The model also does not draw a distinction between different access networks.[84] It can be applied separately to the mobile world or to the fixed broadband world, and the difference shows in different access technologies, devices, and applications. However, as one interviewee pointed out, digital convergence is bringing fixed, mobile, and even broadcast worlds closer to each other, and therefore they should not be considered as separate worlds.[85] The Digital Living Network Alliance (DLNA) shares the same view, as was explained in 3.1.3. Because of digital convergence, it is justified that the value net model does not separate out different connectivity types.

The separate customer value chain shown in the figure is a relevant observation. The subscriber and user are separate roles, because an individual may take either one of the roles, or both of them. A common pattern is that a parent subscribes to a service, for example ADSL, and all the members of that family are end users.

Firms that provide management services for digital homes may emerge from any of the three value chains residing between component value chain and customer value chain. It is common for operators to take roles from all the three value chains, which makes them

[83] Adopted from Smura (2006), modifications made.

[84] The access networks are discussed in 3.1.4.

[85] Expert interviews conducted between September 21 and October 24, 2006.

potential players in digital home management. Examples of relevant business models are described next. The business model descriptions are influenced by the ideas presented in the ECOSYS project deliverable "Business models in telecommunications".[86]

6.2. BIT-PIPE MODEL

A pure bit-pipe operator provides connectivity to the Internet and leaves everything else for third party service providers. The operator only bills for the connection. Charging is based either on the amount of transferred data or on a fixed monthly subscription fee. Fixed fees are growing their popularity as the amount of transferred data is increasing.

Bit-pipe operators' potential margins are small, because they have little chances to differentiate. Third party service providers are able to catch superior revenues with the services they deliver over the connection, bypassing the operator. Bit-pipe operators' main costs incur from operating the networks or renting them from network operators. Figure 31 depicts the revenue flows in the bit-pipe model.

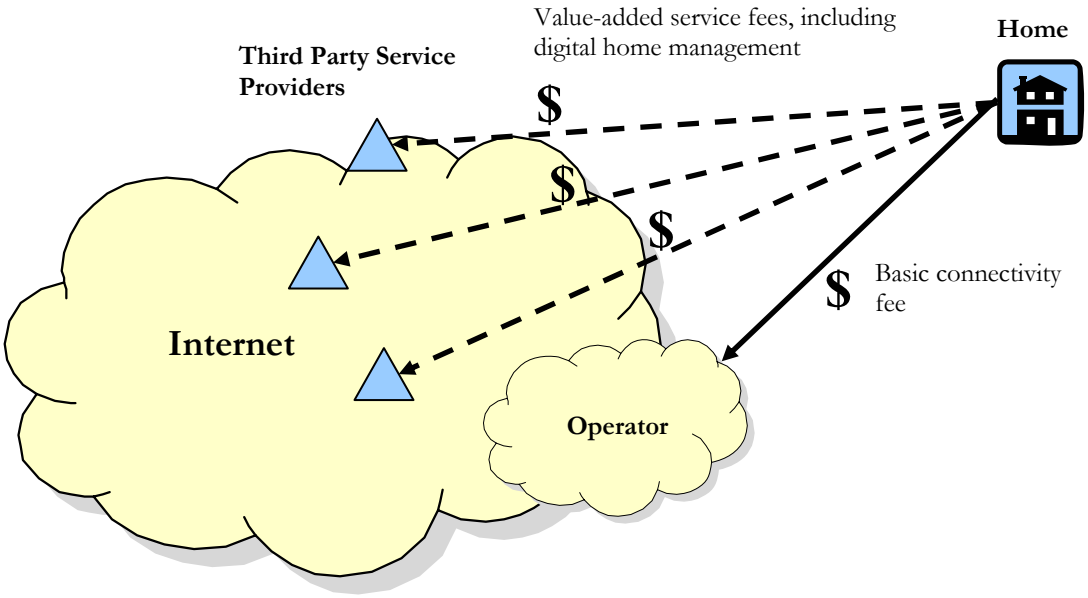

Figure 31. Revenue Flows in the Bit-Pipe Model

The bit-pipe model is actually the core part of operator business. All broadband operators provide connectivity, but the real life operators provide other services as well, and therefore they are not pure bit-pipe operators. For example, the leading Finnish

[86] ECOSYS (2004)

operators Elisa, TeliaSonera, and Welho all provide services on top of the connection, such as e-mail, Web page hosting, and security.

6.3. CPE DISTRIBUTION MODEL

An operator using the customer premises equipment (CPE) distribution model provides users with devices. The operator can distribute the equipment in two major ways: by leasing or by retailing. The main difference between these is the ownership role. When a lease is signed, the operator preserves the ownership, while the customer gets the right to use the equipment for the time agreed in the contract. In a retail transaction, however, the ownership immediately shifts to the customer, even if the equipment is paid off in installments during a fixed-term contract.

By expanding into CPE distribution, an operator not only broadens its product catalog but also increases customer lock-in. With fixed-term contracts, the operator gains predetermined revenues for a predetermined time. The operator may provide subsidies to the subscribers in order to attract them to sign contracts. The subsidies and device management costs along with the CPE investment costs are the largest expenses in this business model. The revenue flows of this model are shown in Figure 32. The operator purchases equipment from manufacturers or wholesale vendors, creates retail packets from the devices, and sells or leases them forward. To reduce the risks that incur from owning the devices, the operator may want to use a third party financing company that instead of the operator purchases the devices from the vendors.

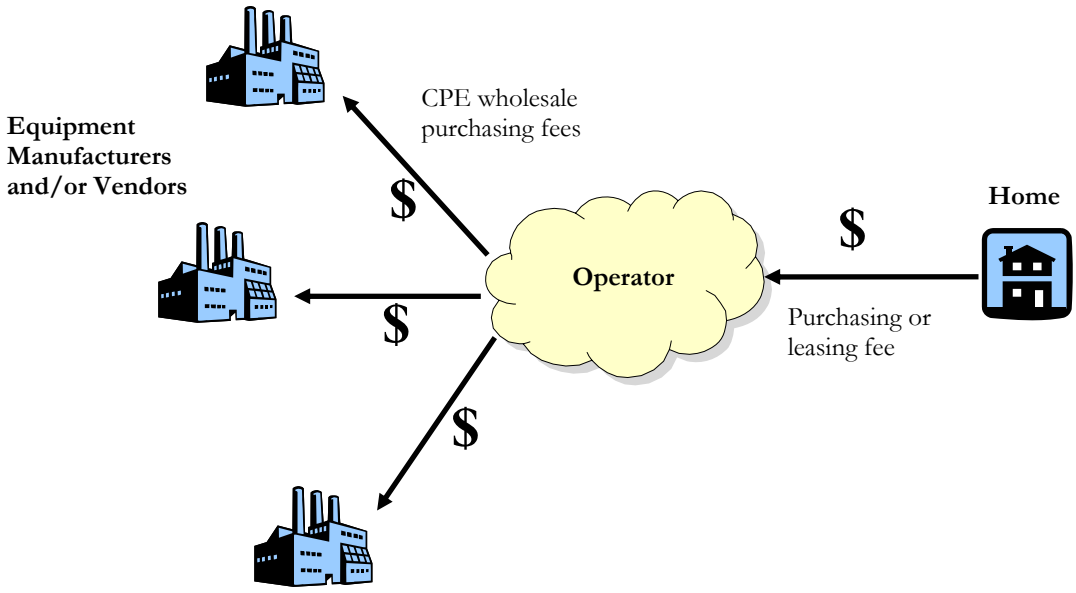

Figure 32. Revenue Flows in the CPE Distribution Model

Among the largest Finnish broadband operators, Elisa and TeliaSonera have expanded into CPE distribution at the time this is being written. Other large operators, e.g. Maxinetti and Welho, only provide modems with subscriptions. Both Elisa and TeliaSonera sell PC packets that the customer pays in installments during a 36 month period. The customer gets the ownership right from the start. A regional Finnish operator Lännen Puhelin has gone further: it offers complete digital home entertainment packets that customers can either purchase or lease.[87]

6.4. SERVICE INTERMEDIARY MODEL

In this model, an operator acts as an intermediary between third party service providers and home users. The operator does not provide its own digital home management services. Instead, it brings together service providers and customers, and enables transactions between them. It is able to do this, because it has an installed base of customers for whom it can create attractive service bundles by aggregating its own offerings with third party management offerings. The operator takes care of charging and billing. It sends each customer a single bill for the whole service bundle. Then it allocates revenues back to third parties, retaining a part from the revenue flow for itself.

[87] Lännen Puhelin Web page: http://www.lannenpuhelin.fi/ (Accessed February 12, 2007).

This business model is attractive for operators, because the third party service providers carry the most of the business risks. Billing is the main cost element for an operator using this model. Figure 33 depicts the revenue flows in this model.

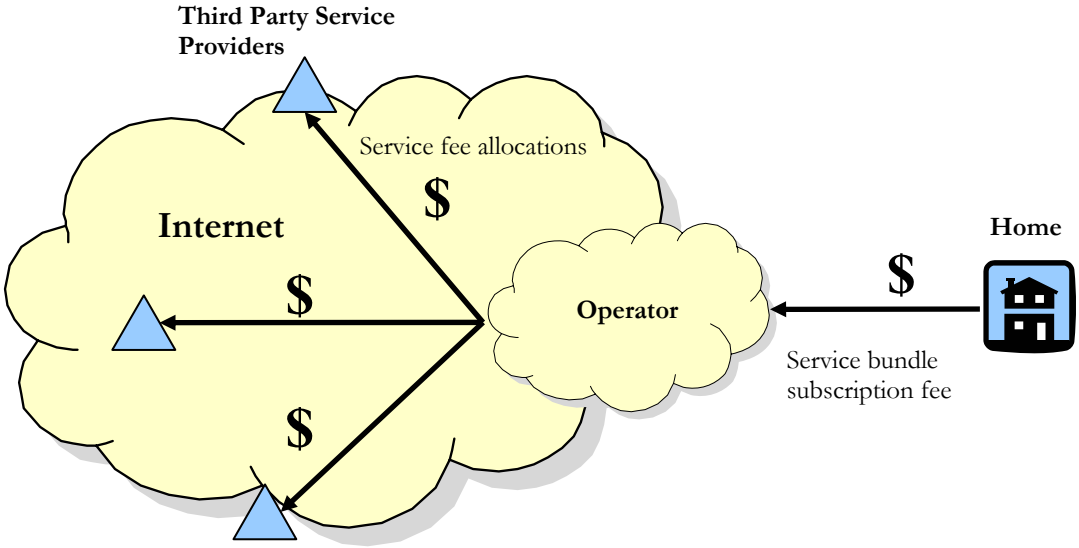

Figure 33. Revenue Flows in the Service Intermediary Model

The service intermediary model is currently used particularly security provision. For example, Elisa sells a security solution with a fixed monthly fee. Elisa markets it as "Elisa Data Security", even though the solution essentially includes virus protection and firewall software applications from F-Secure.[88] In other words, F-Secure is the actual security manager, and Elisa is just an intermediary.

6.5. UPDATE AGGREGATOR MODEL

An operator using this imaginary business model assists end users in the software application update process. It gathers updates published by various software houses, runs tests on them on a centralized server, and then distributes them to end users. The operator's role in this model is resembles the IT administrator's role in organizations. Also the value is similar: the end users only need to access one server to load the updates. Consequently, configuring firewalls is easier, and the updates can be tested in advance on the server to ensure that they are working and safe to install. It is possible that the operator installs the updates remotely into home users' terminals, or that the devices automatically check for new updates.

[88] Elisa Web page: http://www.elisa.com/en/ (Accessed February 12, 2007).

The update aggregator model alone is not likely to create revenues, because it is unlikely that end users are willing to pay extra for this kind of service. The reason is that updates are available for free directly from the software houses for users who know how to load them. However, update aggregation could be implemented as a part of a broader digital home management offering that would minimize the need for user intervention. In such a case, the cost of update aggregation would be hidden inside a service bundle. Figure 34 shows the revenue flow and software application flow in this model.

For the time being, there are no operators using the update aggregator model. The model could be used in scenario 1, where it would be part of a comprehensive management solution, such as the one discussed in the next section.

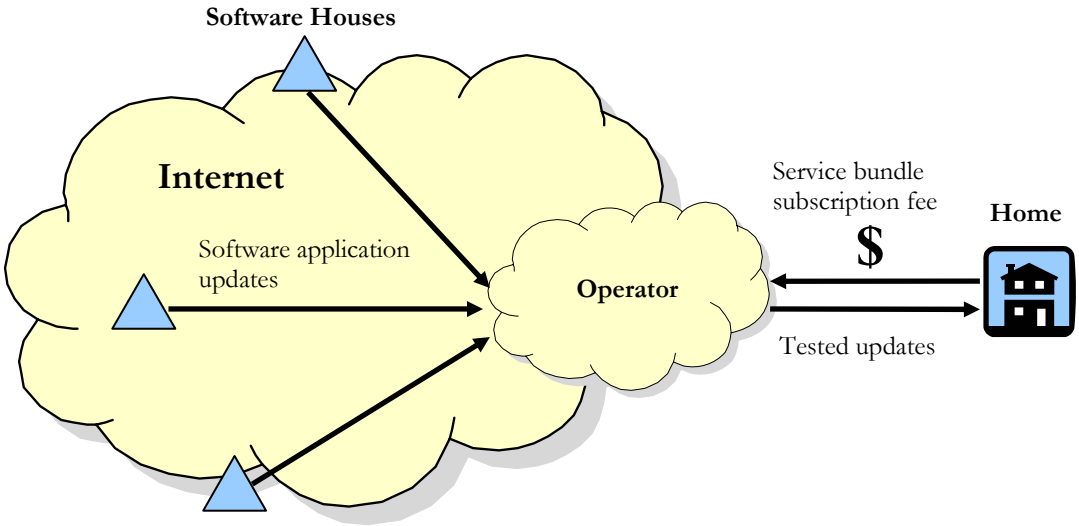

Figure 34. Update Aggregator Model

6.6. TOTAL MANAGEMENT MODEL

An operator would use the total management model in scenario 1 to provide comprehensive management services to its customers. This model integrates all the other models discussed earlier in this chapter. The result is a solid all-inclusive offering that minimizes the need for customers to participate in management. The operator would deliver connectivity, equipment, security, software application updates, support, and on-site installation. It would probably not provide all the services by itself but it would be an intermediary between end users and third party SPs such as security firms and IT janitors.

The total management offering would be marketed under the operator's brand name, even though the offering would involve services from various players. The value is that the offering would be easy to understand and the whole bundle could be assigned a single price that the customers would pay each month.

6.7. DISCUSSION

In the PC world, it is relatively easy to decrease the amount of manual management work by automating separate management tasks. For example, automating software application updates is already possible. It is, however, not enough to consider management tasks separately, since everything in a digital home must work seamlessly together. Among the key findings of this study are the following two bottleneck problems that are slowing down the adoption of home networks and digital services:

- Initial installation and configuration, part of which has to be done on-site.
- Integration of different management tasks into a comprehensive solution, so that the home system runs continuously without the need for users to intervene.

According to the interviewees, people will most likely not be willing to pay separately for management.[89] This results in two choices for service providers:

- They can aggregate management with other offerings, and this way hide the cost of management from the users. This is what operators are doing in scenario 1 and software platform firms are doing in scenario 2.
- They can choose business models that do not involve direct consumer billing. The service providers may get the revenues for example from advertising.

Operators are in a privileged position compared to other service providers. As mentioned earlier in this chapter, an operator can take roles from all the three value chains that lead to homes. Taking a closer look at Figure 30, one can also perceive that the possible operator roles reside close to the end user. Consequently, operators have the potential to create tight relationships with home customers.

Providing management services to the homes is a way for operators to increase their control over home users. At the same time as operators increase their control over

[89] Expert interviews conducted between September 21 and October 24, 2006.

homes, they grow stronger in relation to other companies that are competing for home users. As a result, digital home management is a potential leverage to the provision of other services as well, for example triple-play and home automation. Operators should consider these advantages when pondering on the costs that incur from offering management services.

7. Conclusions

This chapter summarizes the results of this thesis and assesses them critically. Then it explains how the results could be exploited, and finally suggests topics for further research in the domain of digital homes.

7.1. RESULTS

An important contribution of this thesis is that it guides the discussion about home networking into management of digital homes. The motivation for the analysis has been drawn from recent research papers, business strategy and scenario analysis literature, and expert interviews. This thesis has brought established concepts from various sources into a new context.

The scenarios constructed in this thesis describe four possible future environments for management of digital homes. The role of an operator in relation to other potential management service providers is explained in each scenario. Scenario 1, the locally centralized scenario, is the best case from the operators' perspective. Management service business will grow large in that scenario, and operators will end up having the most control. The do-it-yourself scenario, denoted by number 4, describes the future business environment in case management service business does not take off. The remaining scenarios falling between these two extremes describe cases where management service business is significant, but the role of an operator is not particularly strong.

This thesis deliberately refrains from evaluating the likelihoods of the scenarios to become reality, which supports the ultimate purpose of the scenarios: they should not be taken as forecasts but as novel ideas to help prepare for the future. Because the direction of the future development of digital home management is yet unknown, the business model examples are quite vague. It is rational to wait until the market uncertainty decreases over time before developing more detailed business models.

7.2. ASSESSMENT OF RESULTS

It is important to note that home networks are still in an early stage. Lack of dominant design and ongoing rapid development of technologies are just two sources of the uncertainties that the industry is full of. Scenario analysis is suitable for this kind of a

situation, but the results should still be taken critically. It might be that the future will not resemble closely any of the four scenarios constructed in this thesis. The reality could include flavors from several of them, or it might turn out to be something radically different, for example if a disruptive innovation changes the whole array. Because scenario analysis builds on what is known today and what is uncertain about tomorrow, the process must be repeated regularly. As uncertainties get resolved and new ones emerge, the scenarios already defined become obsolete.

The thesis is written from the Finnish perspective, but the key ideas are applicable to other European markets as well, because the regulations and consumption habits are quite homogeneous in the EU member countries. The United States is a dissimilar market, where cable operators are stronger than DSL operators are. In reference to pay TV, it seems that U.S. consumers are more willing to pay for content than European consumers are. The Asian markets are interesting as well, particularly South Korea and Japan, where network technology development has been rapid and consumers are known to easily adopt new electronic devices.

7.3. Exploitation of Results

Service providers might be interested in the conclusion that digital home management is important for the spread of home networking. The scenarios can be used to accumulate a new mental model about the possible future development of home networking. The trend weightings and "Evolution from 2007 to 2012" stories present signals that drive the evolution towards each scenario. Decision-makers should continually scan the business environment for these signals of change. Detecting such a signal in an early phase gives the decision-makers time to prepare for the consequences.

7.4. Topics for Future Research

This thesis has concentrated on the management services for digital homes. The services discussed are provided over a broadband Internet connection to the home premises. The following topics have potential for future research:

- **Remote connectivity and related services**. Remote connectivity means accessing the home network from a remote location.

- **The role of a mobile operator at the digital home**. Mobile handsets are becoming increasingly important output devices, but it is yet unclear how this will affect mobile operators' business.
- **Interconnecting home networks with each other**. Operators might have a role in managing the cross-home connections and providing new kinds of services that these connections enable.
- **The linkage between management of digital homes and other services offered to digital homes**. This thesis has deliberately discussed management of digital homes as an entity. Similarly, there are studies that have concentrated independently on other service areas, e.g. home automation or digital content. How the services would work together, integrated by digital home management, is a potential topic for research.
- **Assessing the scenario framework and its applicability to other research problems**. The scenario framework used here is fresh, and for now, it is unknown whether it has been utilized in other contexts in addition to the original source and this thesis.[90]

[90] The original source is Karlson et al (2003).

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9. Appendix: Summary of Expert Interviews

Management Structure

Will the end user terminals be managed at home or remotely by a service provider (e.g. software installations)?
Will data security be managed by the end user, or are security services offered by a service provider (e.g. firewall, virus protection, security updates)?

The rapidly growing number of electronic devices at home has made it very difficult for many people to configure and keep their digital home up to date. There are a myriad of device manufacturers, each putting their own user interfaces into the gadgets, which increases the complexity. The case is worst in PC world, where software needs to be updated regularly and security threats are becoming ever more common.

The group of people that can and want to manage their firewalls, virus scanners, and operating systems is marginal. Nevertheless, they must have the opportunity to take care of these things by themselves. This type of a management structure is said to be distributed, because the management is spread around the network to the end users. For the rest of people – the great majority – management needs to be offered in a more centralized form, namely as services from outside the home. In PCs this is already happening: users can decide whether they want to: (1) purchase firewall or virus scanning software so that they own and manage it by themselves or (2) pay by a monthly basis their broadband operators to take care of security issues.

Security is just one element of the complexity in digital home systems, but it could act as a forerunner for other application areas to move into the centralized direction. Other potential things mentioned by the interviewees that could be managed remotely are mobile phone configuration, setup of broadband connection, file management and backup, and error correction. For the end user, a convenient scenario would be such that any networked device would automatically be configured when connected to the public network.

A management service can involve physical visits of technicians in case of a malfunction or a need to change the home network configuration. Most interviewees considered, however, it probable that remote management will become more common. A trusted outside party could for example scan the home computer, find the problems, and fix

them. One problem with remote management arises from privacy issues. The prevailing attitudes are that device owners are not willing to let anyone else control their property.

To sum, the opinions were quite similar. Management structure is considered an important but also uncertain variable. The trend is that service firms, especially operators, are advocating for centralized management. The most significant uncertainty arises from customer attitudes, because their willingness to pay for these services in the future is unknown. Other affecting elements are development of remote management systems and success in bundling management services with connectivity or other value added services. One important point stood out from the opinions: although management is moving away from the home, it is not necessarily moving into large centralized service providers. The provider of each service will instead manage its own offering. For example, the connectivity provider will handle connectivity-related updates, and a content retailer will update its services.

Service Architecture

What will the overall service architecture look like?
Is the intelligence going to be in the terminal or in the network, or both?

For the moment, the end user terminals are filled with more and more capabilities, and the trend seems to be continuing. This can be seen for example in smart phones, PCs, digital music players, and digital set-top boxes which are all adding ever more functionalities, memory and processing power. At the same time on the application side, Web applications such as wikis, Internet forums, social networking sites, and blogging are increasing their popularity. Web applications are centralized, because they are accessed with thin clients (browsers) and the application intelligence is loaded over the network each time the application starts. Nearly all interviewees anticipated that application intelligence is moving more and more to the network.

The business environment in PC software and services should be regarded as a potential reference to home systems. Businesses are often ahead of homes in technology adoption, such cases being for example e-mail and VoIP. One ongoing trend in offices is moving from desktop applications to Web applications, in other words moving from using locally installed software to using it online with a Web browser for some usage based fee. The business role that provides this service is called an application service provider (ASP).

The digitalization of content creates needs for new types of services. Self-made digital content such as photos and video clips need to be stored securely, which opens up possibilities for service providers. Home users often do not care to take backups of their files because it requires additional hardware and takes time. A rational solution is therefore to use a network storage service such as TeliaSonera's Tietovarasto.[91]

Network digital video recording is another interesting application area. Instead of selling or leasing DVRs to home users, an operator could record programs for customers inside its own network.[92] Customers could record and play programs over the network through a user interface at home. According to a recent test conducted by Cablevision, the costs for an operator running a network DVR system are as low as one third compared to the costs incurred when equipping homes with physical DVRs.[93] This way the operator is virtually able to offer video-on-demand services.

To gather it up, the big picture according to the expert opinions seems to be that there will be intelligence in both terminals and network. The physical capability of terminals continues to increase, but at the same time more and more services are provided in the network.

Service Aggregation

Will the services be offered in bundles, or is everything offered separately?

The interviewees had very similar thoughts on service aggregation: everyone argued that bundling is becoming more popular. Service providers have various reasons for bringing different services together, depending on their business role. For example, a company having a large product or service portfolio can better predict customer valuations when it offers multiple products or services in a bundle than when selling them with separate prices.[94] In addition, customer lock-in increases as the customers become more dependent on the same provider. Content firms on the other hand are willing to be part of well-branded bundles, because they need market visibility and access to consumers.[95]

[91] Tietovarasto is a supplementary service to a broadband connection. It is priced as a monthly basis, e.g. 9.49 € for 10 GB. See http://www.sonera.fi/ (Accessed October 31, 2006)

[92] Leasing customer premises equipment is commonplace e.g. in the U.S.

[93] Stump (2006)

[94] Bakos & Brynjolfsson (1999)

[95] Interview with Seppo Nieminen, October 3, 2006.

Triple play, or convergence of broadband Internet, telephony, and television, is the major playground for service bundling. It is presumable that the bundling environment obscures the boundaries between industries. What today are known as telecom operators, cable operators, and media companies might in the future be triple play companies all offering similar sets of services. In a case like this, where the market is filled with similar competitors, owning a strong brand name is an essential success factor.

For the customers, bundling is not always a positive thing. Even though they pay a lower total price for the bundle of services than when buying the same services separately, bundling also makes it more difficult for them to change the provider. This is because bundling often involves signing contracts that bind the customers to the same provider for a given length of time.

Regulation is a major causal factor of the future of service aggregation. As it is visible in the Finnish mobile phone and mobile subscription market, the regulator can prohibit bundling of certain services if it sees that bundling would be harmful to the consumer or total welfare. Conversely, the regulator may also force service providers to offer certain services together. France is an example of a country where ISPs are obliged to offer parental control service with an Internet connection without charging for it separately.[96] These types of directions could well become more common, so that eventually no firm would be allowed to sell insecure connections to consumers.

Although the interviewees agreed that the number of bundling offerings will increase, they also thought that customers should and will be able to buy the services separately. Several experts considered this an important variable for the future of home networking services, because attractive bundles are needed to grow customer base.

Access Technology

What will be the winning technology to access public network from home?
Which one will be the winner: wired or wireless?

Standardization organizations and companies are putting efforts on the development of new wireless technologies. Commercial WiMAX implementations already exist, and WLAN hotspots are growing in number. Other interesting emerging technologies are for example the HSPA evolution to WCDMA, and Flash-OFDM. However, none of these

[96] European Digital Rights. See: http://www.edri.org/book/print/858 (Accessed October 16, 2006)

technologies will be able really to compete with fixed broadband in providing public access to the homes. Wireless technologies simply cannot match the growing performance demand. As voice and television move into the IP world, consumers demand ever better QoS and higher data rates.

The Finnish Government gives one measure for the future requirement for bandwidth in the National Information Society Strategy.[97] The vision is that by 2015, the average household has a 100 Mbps connection, while new and renovated buildings are equipped with fiber connections providing data rates of up to 1 Gbps. As a result, wireless technologies will be relevant mostly when the user is not at home, or in areas where building wired network is not worthwhile. This means that the most bandwidth-demanding services will not be available in those areas.

The future of this variable is quite clear; nearly all the industry experts agreed on the win of fixed broadband. Those who were not certain about this rationalized their comments by stressing the high wiring costs in sparsely populated areas. However, as most people live in urban areas, the significance of wired connections is emphasized. This is an essential discovery, because it underlines the importance of broadband operators in the prospective telecommunications industry.

Intra-home Connectivity

What will be the order of importance for connectivity inside homes: wireless, Ethernet-like communications wires (Ethernet), electrical wires (PLC)?

According to the interviews, the winning technology for intra-home connectivity will be some wireless technology, probably WLAN. Wireless technologies provide superior convenience by offering intra-home mobility and releasing users from the burden of wiring the house. Some of the interviewees said that there are still problems with reliability, but they believed that these will be solved in the following couple of years.

The negative thing about Ethernet-like communications wires is that putting wires around the house is difficult and expensive. Given the superior performance, reliability, and security, communications wires would otherwise be a good option to build a home network.

[97] Information Society Programme (2006)

The interviewees did not believe that power line communication would get popular at least in the near future. The good thing about PLC is that there is no need for additional wiring. However, there are still many problems that need to be solved before this technology can be widely adopted. Some of the problems that were mentioned are lack of standardization, interference caused by light switches and electronics, too low data rates, and security problems.

Home networks are not tied to any specific network technology. Several technologies may be used simultaneously, so none of the three media mentioned above is going to vanish. One sensible solution is that a few backbone links in the network would be wired, and the other links were wireless. For example a desktop computer or a TV both have somewhat predetermined places in the home so they do not need mobility.

End User Terminal

Will one end user terminal be used to control the others?
If there is a dominant terminal, what will it be (PC, mobile handset, other)?

The expert opinions on a possible dominant end user terminal varied greatly. Each view can however be put into one of the following categories:

1. There will not be a master terminal. Instead, many terminals can be used to control the home devices. The terminal could be for example a mobile phone, PC, PDA, or TV, and the choice of terminal would each time depend on the situation.
2. The center of the home system will develop from the PC world. PCs being the first devices to be connected to the Internet are the natural choice for storing content downloaded from online stores. Equipped with media center capabilities, the PC can be used to stream content and control other home devices.
3. There will be a dominant device in the center of the home system, and it will develop from the home entertainment world. Consumer electronics are usually designed to esthetically fit in the living room, while computers are initially meant to be located in the den. The master terminal may be a totally new device, but it could also evolve from an existing device such as a DVR or a set-top box.

The central terminal in the last two categories would have some fundamental characteristics regardless of which industry sector it emerges from: other devices connect to it, and it can be used to control them. The functions on top of this could include

anything from Internet telephony to online gaming. Added capabilities will, in the end, result as the device resembling closely a PC. It is notable that the possible emergence of a master terminal depends on what the users think is the most convenient way to operate the devices. The easiest way to watch a movie in the bedroom, for example, is not going to the den and telling the computer to stream the movie. It should be possible to put the movie running with the TV that is located in the bedroom.

Mobile handsets have an exceptional role in the home network, which results from the two special characteristics they have. Firstly, unlike most other home devices, the mobile handset is personal by its nature. Secondly, it can provide connectivity to the home network from outside the home.

Taking account the differing opinions, this question is undoubtedly full of uncertainty. Still, it did not get on to the list of critical variables. The reason for this is probably that the terminals used at home do not have all that significant impact on the service business. In addition, this variable depends on the Designs & Interoperability variable discussed below, whose significance for the industry structure may have lowered the status of end user terminals.

Designs & Interoperability

Is there going to be a single dominant design for home system architecture, or several competing ones?
Will different designs be interoperable?

This is a key factor in dictating which direction the telecom business is heading to. There need to be extensive designs that are easy to use, before home networks break through in the mass market. At the moment there are no firms offering complete digital home systems; current solutions build up just parts of the whole system.

This question can be divided into two dimensions: hardware dimension, and content and applications dimension. According to the interviews, there will be no single dominant design ruling in either dimension. On the contrary, users will most likely build their networks piece by piece, and each time they expand their networks they should be able to choose among several suppliers. For instance, there probably will not be pure "Microsoft homes" or "Apple homes". Even though these are powerful companies, they do not provide everything needed at home. This is why they should provide products that are interoperable with the ones available on market.

In the content and applications dimension, the case is more complex. There are many different content formats both in audio and in video, originating from companies and standardization organizations. For the user the format should not make any difference, as long as the quality is fine. Digital rights protection makes the issue even more tangled, because media companies wrap their content files with DRM technologies, preventing users from copying the files or playing them in unauthorized devices.

Summing up, it is still unclear what designs will gain popularity and how many there will be. Interoperability is important to achieve but this is hindered by the current DRM solutions. They need to be opened up before interoperability can expand into the content dimension.

Proprietary Solutions

Will the dominant design(s) for home system architecture be based on proprietary solutions or on standardization work?

This is a relevant variable and has influence on the previous one. The expert opinions were surprisingly polarized. The stand that the breakthrough happens through standardization work got a bit more support, but some interviewees were very certain about the opposite view. Considering the answers together, it seems that both ends are needed to get home networks going. The initial spark needs to come from some standardization alliance that is supported by key industry players. When there are common rules for certain fundamental elements, such as DRM solutions and file formats, the companies can put their efforts on developing them further.

Players

Who will be the main players in the industry (mobile operators, broadband operators, content firms, or some other service firms)?
Will the incumbents rule or will there be powerful new players?

According to the interviews, the possible rise and success of multi-play offerings is a key factor dictating what business roles are the most relevant in the future. Those firms that are able to provide multi-play bundles will have significant control on homes, because they can give centralization discounts and this way increase customers' switching costs. Such firms can be those that today are known as telecom operators, cable operators, or content firms. The common denominator for multi-play companies is that they all have the network capacity needed to offer the different services.

A couple of interviewees said that pure mobile operators are not likely to increase their power at home. This results from the fact that they do not have the capacity to offer heavy digital content and services. They will retain their position though, because mobile handsets offer the individual communication service and ultimate mobility that other devices cannot.

There was one fresh idea that differed from the conventional views: broadcasting companies could have a major role not only in television services but also in other digital content and services. The reasoning behind this is that broadcasting technologies enable a significantly more cost efficient way to deliver data than the traditional broadband technologies. Although broadcasting allows only one-way connectivity, Lindqvist saw that this does not constitute a problem for certain types of applications that do not require too much interactivity. Equal to a newspaper subscription, where the subscriber cannot influence the set of articles the paper contains, a digital television viewer cannot influence the content inside the broadcast. The viewer does not even need to influence the broadcast, because he or she may choose desired content in the same way as the newspaper subscriber chooses which articles to read.

To gather it up, the service value network builds up from various players. Which are the most relevant ones depends on the point of view. For the consumers, the most visible companies are those who deliver the products or services, send bills to homes, and offer customer service, for example. From the supplier point of view, the most relevant players are those that get the biggest pieces of the cake. It is an open issue how the profits are going to be allocated.

Pricing Solutions

What kinds of winning pricing solutions will there be?
Who will take care of charging & billing (e.g. mobile operator, credit card company, or some other)?

The opinions on future pricing grounds were quite similar. Actually, according to the experts' views, the current pricing solutions are not going to change much. Connectivity has flat rate pricing, whereas in value added services there are many different pricing solutions. Content can be charged by unit basis or by selling subscriptions that give access to certain titles. The same is with services: pricing may be based on number of transactions or on a fixed weekly or monthly fee that provides access to a set of services.

The pricing of a service depends on the type of service in question; data security for example has a fixed price, because it cannot be divided into transactions.

As it came out in the interviews, the business role that takes care of charging and billing is important. Mobile and fixed operators are potential players to take this role, because they already send bills to homes. In addition, credit card companies and banks are possible players, but now their systems require typing either lengthy credit card numbers or passwords, which is inconvenient for the user especially if frequency of payments is high. Small players cannot put up charging infrastructure, so they need to outsource charging to larger companies. This may open up business opportunities for those that have this infrastructure.

Ownership

Are the users going to purchase own devices, software and content, or is everything delivered as services?

When showing this variable to the interviewees, several of them said first that Finnish people want to own rather than lease things. This is particularly true in televisions, PCs, and other hardware. However, there are examples of hardware offered as services, too. Welho and TeliaSonera both offer rental modems for their cable modem connections, and Lännen Puhelin has offerings that contain all devices needed to build digital entertainment systems.[98]

To sum up the answers, it seems that ownership is going to remain dominant in the near future, even though service form is gaining popularity. In hardware, the change will take more time, and attitudes need to change, but as on-demand content offerings spread, service form will get more significance.

Access Openness

Who will be allowed to access the Internet from the home network: strangers (authenticated / no authenticated, friends-only, or nobody outside the family)?

More and more people are concerned of data security issues, but often they only think of threats coming from the public network. Wireless networks however introduce a new interface that makes home systems vulnerable. If the home WLAN is not protected, anyone can connect to it with a device having WLAN capability. The usual case is that a

[98] See http://www.welho.fi/, http://www.sonera.fi/, and http://www.lannenpuhelin.fi/. (Accessed 17.10.2006)

neighbor gets free Internet access at the WLAN router owner's expense, which is not very harmful if the neighbor does not consume too much capacity. Problematic is, however, that a skillful intruder might get into the home network and devices connected to it. This is why WLAN users should secure their networks. Nevertheless, it seems that they fail to do this, which indicates that current security solutions are too difficult for most users to configure.

This variable assumes that the WLAN protection is in condition and the home network users are able to decide whom they will let into the network. The interviewees were quite well aligned in this: only members of the family and their friend visiting the house will be given access. The friends may access the public network using their own WLAN capable devices, or they can use some of the networked home terminals. Nobody outside the family will be let to the files stored inside the home network.

The interviewees did not consider wireless communities such as Finnish OpenSpark[99] and Spanish FON[100] as an important phenomenon. One argument on this issue was that operators might want to prohibit connection sharing, while some interviewees saw that most people simply are not open enough for this type of community – it suits for people with peer-to-peer mentality.

Value Creation

What new value will home networks bring to consumers?
What services will be most valuable?

Interestingly, although nobody questioned the importance of home networking this was a tough question to answer. Many interviewees had to think for a moment before they could identify what is valuable about it, but in the end, the comments were quite similar. When talking about value perceived by consumers, the main points that came out were the following:

- Accessing different services offered over the network becomes easier and more convenient. Services and content can be accessed in any room with many different devices, and content can be visible in several rooms simultaneously. Also paying for the services will be convenient.

[99] See OpenSpark's web page: http://www.sparknet.fi/en/OpenSPark.html (Accessed October 16, 2006)

[100] See FON's web page: http://en.fon.com/ (Accessed October 16, 2006)

- Producing, storing, and distributing self-created content becomes easier.
- There will be more interactive options alongside passive television.
- Remote management services will free consumers from certain laborious tasks.
- Remote connectivity to the home network will enable accessing files from anywhere. One could for example show a friend photos that are stored on a home computer or on a network server using a mobile phone. It could also be possible to control home devices remotely.

In the service provider point of view, home networks are valuable in several ways. The threshold to use networked services decreases, and as a result the consumption of purchased content and services increases.

Service Availability

How much will there be services and content that is feasible to deliver through home networks?

The consensus is that there will be plenty of services offered over the network. Many currently existing services are suitable; home networking is no enclosed area but affects the provision and usage of current services, and probably also creates new opportunities. Obvious service categories are digital content, television and radio, communications, and network gaming. Nevertheless, there are no clear limits for what can be offered over the net: physical goods are sold in online stores; home automation will probably gain popularity some time in the future; management of certain digital home devices can already be outsourced to some service providers, and so on. Overall, home networking will make it easier to access all these services and pay for them.

Virtual Home

Will the home network be considered to reside in just one physical place, or can home be accessed from anywhere at anytime?
If there is ubiquitous access to home, will the concept of home change, because you can always connect to the "virtual home"?

This variable was added after discussing with the first interviewee who regarded it as very important. However, other experts did not list it among the three critical variables. Perhaps they thought that there is little uncertainty. Everyone believed that remote connectivity to home network will become a fact and will create value for the consumers.

Home network must be secured from outside intruders, so remote connectivity requires a strong identification solution. If the connection was taken using a mobile phone, the

SIM card could be used to identify the user. Using some other terminal, such as the PC of a friend, would require some other solution. Offering secure remote connectivity is a new management service that could fit well for example into broadband operators' service portfolios.