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EVOLUTION OF OPERATOR BUSINESS MODELS IN THE FUTURE INTERNET OF THINGS

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ABSTRACT

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The Internet of Things is a paradigm or vision, where virtually any object can be connected to Internet, enabling new smart services to people and businesses. Mobile network operators have entered the aspiring market, but because of the novelty of the paradigm, many aspects of business and technology in the area are still undiscovered. In this thesis, views of possible mobile network operator business models were presented, and the object was to discover, how mobile network operator business models change in the future Internet of Things. The research based on theoretical concepts of value, innovation diffusion and technology adoption life cycle, as well as business models, corporate strategy and enabling technologies constituting Machine-to-Machine communications and the future Internet of Things.

The qualitative research method used in this thesis was based on Mika Mannermaa's evolutionary futures research, and it was applied to concepts of business model evolution and innovation life cycle models. Theoretical basis of the research was presented using literature, and the methodological framework was constructed using both life cycle models and system methodologies.

Main findings of this research indicated, that a mobile network operator's business models change as the diffusion of innovation, the Internet of Things, continues. Several key elements of the business model evolve, as technology is adopted more and the surrounding ecosystem grows creating more actors and relationships between them. A guideline for mobile network operators was proposed to support the business in the future Internet of Things

In the end, research and results were reviewed and future research objectives were found, especially regarding middleware platforms and information security.

Keywords: innovation; mobile network operator, business models, diffusion

LIST OF ABBREVIATIONS

ARPU	Average revenue per user
ASP	Application service provider
B2B	Business to business
B2C	Business to consumer
B2B2B	Business to business to business
B2B2C	Business to business to consumer
BMC	Business model canvas
IoT	Internet of Things
M2M	Machine-to-Machine
MNO	Mobile network operator
MSP	Multi-sided platform
MVNO	Mobile virtual network operator
PaaS	Platform-as-a-Service
PLC	Product life cycle
QoS	Quality of service
RFID	Radio frequency identification
SLA	Service level agreement
SSM	Soft systems methodology
TALC	Technology adoption life cycle
WLAN	Wireless local area network
WPAN	Wireless personal area network
WSAN	Wireless sensor and actuator network
WSN	Wireless sensor network
WWAN	Wireless wide area network

FIGURES

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1 Introduction

The Internet of Things (IoT) is a vision, where physical objects are connected to the Internet. According to the vision, any physical object can be equipped with processing and networking capabilities and sensors, with which the object can observe itself and its environment, generate information and communicate it to networks. As it is expressed in the ITU-report on the Internet of Things (2005), the IoT gives birth to a new dimension of connectivity, from any place and any time, to any place, any time and *anything*.

Development of information technology, Machine-to-Machine (M2M) communications technology, Radio Frequency Identification (RFID), wireless sensors and actuators (WSAN) technology and microelectronics, have impacted to the gradual realizing of the IoT vision, together with miniaturization of technology, lowered energy consumption and declining prices of processors, sensors and communication modules (Fleisch, 2010; Leminen, Westerlund, Rajahonka & Siuruainen, 2012; Mattern & Floerkemeier, 2010). Currently, dedicated applications connecting physical objects have been deployed in different verticals using different technologies. However, an open, scalable and standardized Internet of Things is still on its initial stage of its evolution, not to mention regulations or business models.

A business model determines how a company creates value to its customers. Business models also define the company's boundaries by determining company's key business partners. (Zott, Amit & Massa, 2011.) To leverage on the IoT, companies should construct suitable business models, taking into account technological, economic and socio-political characteristics of the IoT. As different, isolated verticals adopt the IoT, business opportunities emerge for different actors in the IoT ecosystem pursuing economies of scale (Leminen et al., 2012).

Mobile network operators (MNOs) are considered to have an exceptionally strong market position in the future IoT, because they own the infrastructure required for global transferring of data. At present, wireless cellular networks are already used in mobile M2M applications. MNOs offer connectivity services using their networks to M2M service providers, who offer M2M services to end-users. However, offering just connectivity does not leverage on MNOs' all assets, and so MNOs are seeking to improve their position in value networks in the future IoT. The importance of strategy and business model become emphasized, when the balance of markets change because of a technological paradigm shift.

The IoT can be considered as a diffusible, technological innovation, which is adopted by people and organizations. While the IoT is an extension of the current Internet, it creates a whole new idea of things making autonomous decisions and communicating with each other, in addition to be available to interaction with humans. As the IoT paradigm spreads, the market conditions change causing MNOs to alter their strategy and business models. Identifying and anticipating the challenges caused by technology evolution helps MNOs to create strategies and business models, and strive in the future IoT market.

The IoT has been recognized as a major area of scientific research, and several research programs have been initiated globally. Organizations are conducting wide research programmes concerning the IoT. For example, IBM's Smarter Planet program searches ways for efficient use of the vast amounts of data, generated by sensors and machines (IBM, 2013). Possible architecture for the IoT has been discussed in detail in several researches (Sánchez López, Ranasinghe, Harrison & McFarlane, 2012; Uckelmann, Harrison & Michahelles, 2011a; Uckelmann, Harrison & Michahelles, 2011b; M. Wu, Lu, Ling, Sun & Du, 2010). Also, services and application scenarios in the IoT have been identified (Gonçalves & Dobbelaere, 2010; Haller, Karnouskos & Schroth, 2009).

In the European Union, the Internet of Things European Research Cluster (IERC) was initiated by the European Commission to coordinate and integrate several IoT research projects in the European Union (IERC, 2012.) In addition to European projects, national research agendas are commencing. In Finland, the national Internet of Things project was initiated by TIVIT (TIVIT & Internet of Things, 2013). In the project's strategic research agenda (Tarkoma & Katasonov, 2011), total of five research themes are identified:

1. Network and communications
2. Management infrastructure
3. Services and applications development
4. Human interaction
5. IoT ecosystem

This research falls into the fifth theme, which also addresses the creation of IoT business models.

Mazhelis, Luoma and Warma (2012) have defined a generic IoT ecosystem and identified roles in the possible ecosystem. The role of a firm in an ecosystem defines firm's partnerships and, thus, the business model. Leminen, Westerlund, Rajahonka and Siuruainen (2012) have analysed IoT business models with an example from automotive industry. Using a framework, in which business models are differentiated by ecosystem openness and business model's direction to B2B or B2C markets, business models can be identified and analysed. (Leminen et al., 2012.) However, research related to business model change, or evolution, in a time of a technological paradigm shift is limited, and the need for it is acknowledged.

This thesis focuses on the effects of the evolutionary aspects of the IoT to MNO's business models. The motivation of this research is twofold: primarily, gaining information about business model change and the evolution process of business models has a scientific importance for research in business economics and entrepreneurship. On the other hand, by visioning generic business models for MNOs for the future IoT, MNOs can use the information as a strategic aid.

The research question of this thesis is:

1. How MNO business models change in the future evolving Internet of Things?

Additionally, this thesis aims to test the applicability of technology adoption life cycle models to business model analysis, and more specifically, to the concept of Business Model Canvas (Osterwalder & Pigneur, 2010).

This research is conducted as a futures research. Although futures research is not a research method, it is a multidisciplinary filed of research, combining methods and methodologies from different scientific domains. In business economics, futures research can be used as an aid to decision-making and strategy formulating. The objective of this research is not to forecast the future. As Mannermaa notes: "The objective of futures research is not to search the truth concerning the future, but to aim to influence the present."(Mannermaa, 1991, p.326)

An evolutionary paradigm for futures research by Mannermaa (1991) is used as a research framework, within which the view of the future is constructed. According to the paradigm, the future cannot be presumed as steady and linear, but as a sequence of phases of linear development and revolutionary changes or disruptions. The future also includes an increasing degree of complexity of information, material and energy streams. (Mannermaa, 1991.) The IoT can be seen as a revolutionary change, altering the way people and technology interacts.

As a research method, an application of soft systems methodology (SSM) (Checkland, 1985) is used. SSM is used to solve real-world problems in human-constructed systems using modelling techniques (Checkland, 2000). Mannermaa (1991) has adapted SSM to meet the requirements of evolutionary futures research. Mannermaa's adaptation of the SSM is compatible with the systems-oriented view on businesses. The methodology is also easily comprehended and easily communicated as a process. Thus, it also determines the structure of this research process.

First, a view of the system's reality at present is created. This system reality serves as a basis, on which the views of the future are constructed. In the second phase, visions of possible, relevant systems are identified. Core visions are possible, relevant *to-be* descriptions of the system, and they are based on estimations of system's and its environment's developments in the future. In the third phase of the process, future models, corresponding to the system reality, are constructed. In the fourth phase, the future models are compared with the system reality. The last phase entails creating a development program, in which the requisite actions for achieving the desired future state are expressed. (Mannermaa, 1991.)

The future-oriented SSM process is depicted in the figure below (FIGURE 1):

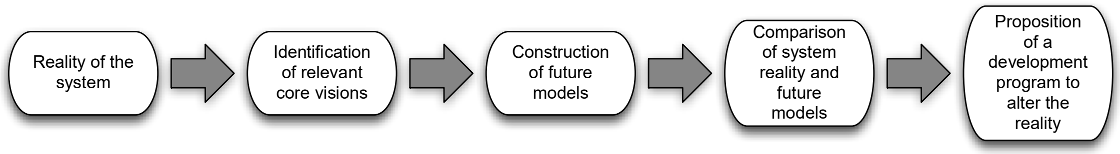

FIGURE 1 SSM process. Adapted from "Evolutionaarinen tulevaisuudentutkimus" by M. Mannermaa, 1991.

A perspective to the emerging IoT market is gained by analyzing the current state of the IoT and MNOs' business. The reality of the system draws on these conclusions of the state of the market, and is then presented as a generalized abstraction of the business model of a MNO. Using information of the future IoT and evolution of telecom industry, and synthesizing it to relevant *to-be* visions of the MNO, hypothetical core visions are constructed. Then, using the technology adoption life cycle model, future business models are constructed for each stage of the technology life cycle, to match relevant core visions. By comparing the future models with the system reality, possible actions for attaining the desired future models are identified and documented as a guideline, or a development program, for MNOs.

Expected results are projections of possible futures of the state of the market and MNO business models. The results may also help us understand the nature of change in the telecommunications industry, and the connected world as a whole.

The research is divided into following chapters: theoretical background, the research method, Internet of Things as an innovation, the system future, future models and last, conclusions.

2 Theoretical background

Technologies and markets experience cyclical fluctuation in terms of product innovation and sales. These patterns are called lifecycles. Their effects on various aspects have been researched widely from business management-, sociological and technological viewpoints among others. In this chapter, three lifecycle models are presented, and their applicability to the research context is reviewed.

2.1 Value and value networks

All organizations aim to create value to their customers. But what *is* value, and *how* is it created? Walters and Lancaster (1999) provide concepts for both a firm's and customer's perspectives. Value is defined as "a preferred combination of benefits (value drivers) compared with acquisition costs"(p. 643), while "a value proposition is a statement of how value is to be delivered to customers" (p. 644).

Value can be divided into components, primarily based on immaterial and monetary value. Khalifa (2004) presents a model for value in exchange, where value is seen as a combination of immaterial value, such as psychic and utility value, and costs and margins (FIGURE 2). Customer perceived net value of a purchased product or service can be equated as $V_{ps} + V_{ut} - C$, where V_{ps} is the psychological value reflecting customer's *want*-factor towards the product or service, V_{ut} is the utility value reflecting the *need*-factor, and C is the sum of both costs related to purchasing the product (price) and transaction costs (searching and information costs). In the case of margin-based pricing, the supplier, id est. the value-delivering firm, adds a margin above the break-even point to capture a part of the created value. (Khalifa, 2004.)

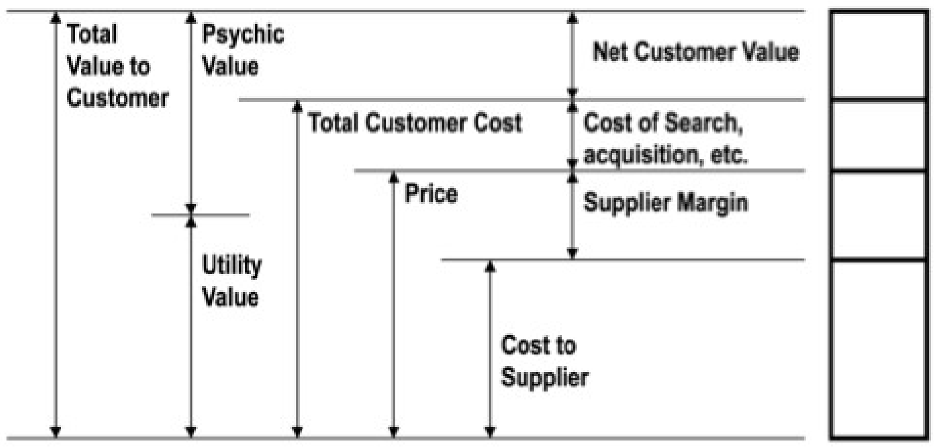

FIGURE 2 Customer value in exchange. Reprinted from "Customer value: a review of recent literature and an integrative configuration" by A. Khalifa, 2004.

Firm's value delivery process is often depicted as a value chain (Porter, 1985), which characterizes value creation as a linear process of a firm. While the value chain is a powerful concept for analysing firm's internal structure and locating weak links between sequential value-adding functions, it is insufficient in describing value creation in modern, networked service economies. Vast amount of completing actors, competitors, regulators, intermediaries and customers as co-creators of value are excluded from the traditional value chain. In order to create superior value, actors in the market form value networks, where value is produced mutually. (Peppard & Rylander, 2006.) In value networks, organizations' foci are not entirely on value-efficient end products, but in the quality of relationships between firms in the network. Companies are interested in other companies' capabilities, to which they could not have access without the value network.

Value networks create dynamics in the market and enable new participants to enter markets through different routes. This dynamics is relevant especially in the high-tech markets, where innovative emerging technologies enable firms to participate in markets in unparalleled ways. Available technology for a firm strongly affects firm's core competences, or capabilities, with which they validate their position in a value network. Kothandaraman and Wilson (2001) propose a model, where these core capabilities and network relationships influence customer value, and vice versa (FIGURE 3). Core capabilities, such as superior technology, determine the amount of value customers of the network receive, which in turn is also reinforced by high quality relationships between the firms. The more value customer receives, the stronger network composition is, thus reinforcing existing relationships. Further, if a firm is part of a value network, it encourages the firm to further invest in their technology to keep or strengthen their position in the network. Last, core capabilities of a firm determines how lucrative a partner the firm is in the eyes of the other firms in the network, thus determining continuity or termination of business relationships. (Kothandaraman & Wilson, 2001.)

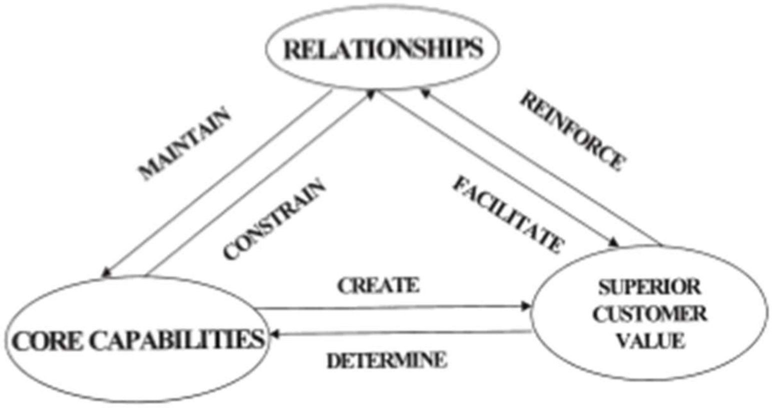

FIGURE 3 A model of value-creating networks. Reprinted from "The Future of Competition: Value-Creating Networks" by P. Kothandaraman and D.T. Wilson, 2001.

To create a strong position in a value network, a firm should create a business model, which leverages on firm's core capabilities creating value to the network. In highly networked business areas and technological paradigm shifts, business ecosystems should be formed in the beginning of a market shift to form value networks around the newly found core capabilities.

2.2 Business model

Business model as a term is, in addition to strategy, one of the most vaguely used in the domain of business literature (Magretta, 2002). Definitions of a business model exist almost as many as there are articles concerning business models, and not all of them are commonly agreed on (Zott et al., 2011). Osterwalder and Pigneur (2010) state: "a business model describes the rationale of how an organization creates, delivers and captures value" (p. 14), whereas Amit and Zott (2001) define, that "a business model depicts the content, transactions, and governance of transactions designed so as to create value through the exploitation of business opportunities" (p. 511). Combining these two popular definitions, a rough definition of a business model could answer to two questions about value creation: what and how? First, a business model indicates the value proposition of the firm. What is the value offered to firm's customers, and what part of the value is captured by the firm? Second, a business model provides an architectural description of an organization, with which value-creating components and the business logic are expressed. Business model can also be considered as a description of value-creation process, i.e., how value is created in the value network. Morris, Schindehutte and Allen (2005) outline six questions, to which a business model should answer:

1. How will the firm create value?
2. For whom will the firm create value?
3. What is the firm's internal source of advantage?
4. How will the firm position itself in the marketplace?
5. How will the firm make money?
6. What are the entrepreneur's time, scope and size ambitions?

The fifth question is often expressed in form of a revenue model, which is also often confused with the business model. Amit and Zott (2001) define revenue model as "[A revenue model refers to the…] specific modes in which a business model enables revenue generation."(p. 515). Inclusion of revenue model to business model is nearly obligatory, but the two should not be used as equivalents or substitutes.

Al-Debei and Avison (2010) list 22 different definitions for a business model from academic literature. In their synthetizing framework they conclude that business models have an ontological structure of components, or value dimensions, which form the structure of the business model and the firm applying it. Many often cited definitions of business models (Al-Debei & Avison, 2010; Chesbrough & Rosenbloom, 2002; Hedman & Kalling, 2003; Osterwalder & Pigneur, 2002; Osterwalder & Pigneur, 2010; Shafer, Smith & Linder, 2005) also analyse them as structured entities with constituting components or elements. Zott, Amit and Massa (2011) conclude, that a business model is a systemic approach of defining how to do business. Therefore, as a unit of analysis, a business model can be analyzed as a system, and using methods from systems research.

System components and their relationships form an architectural view of the company, but the view does not restrict only to single companies. Some components are external to companies, and are part of business networks or ecosystems. Value is created in value networks, which optimize the resources of producing the greatest attainable value possible (Morris et al., 2005). This implies, that a business model is a conceptual system covering a larger entity than a firm.

The role of a business models is to bridge the gap between corporate strategy level and corporation's operational level, both of which are based on real competitive markets (Osterwalder & Pigneur, 2002). Business model however is an implementation and an abstraction of firm's strategy (Seddon & Lewis, 2003) and it is the basis of corporation's business processes. (Al-Debei & Avison, 2010; Osterwalder & Pigneur, 2002) The position of a business model between strategic and operational levels is illustrated below (FIGURE 4). In business strategy, firm's position and actions in the market is planned, but the logic of the actual business is modelled in the business model. From this abstraction of the strategy, firm's strategy is implemented and put into action on the operational level in firm's business processes.

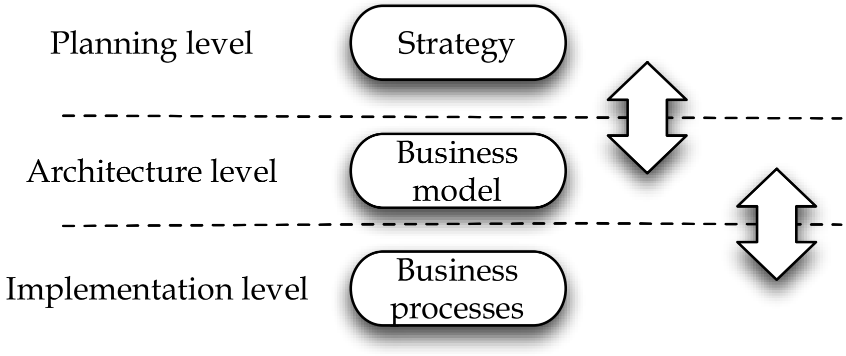

FIGURE 4 Business model in relation to strategy and operations of a firm. Adapted from "An e-Business Model Ontology for Modeling e-Business", by A. Osterwalder and Y. Pigneur, 2002.

Al-Debei and Avison (2010) divide the practical uses of business models into three cases. First, business models are used as alignment instruments, with which the business processes of a firm are aligned with the firm's strategy. Second, business models serve as interceding frameworks, with which new technology and innovations can be capitalized. This is especially the case with successful high-tech companies, who are necessarily not the inventors of a disruptive technology, but are the first ones to exploit it by implementing a revolutionary business model. Last, business models are important knowledge capital for the firms. They are artefacts carrying information about firm's business logic and strategic goals. (Al-Debei & Avison, 2010)

When business models are developed, the first step is to identify the elements of the firm that belong to the domain of business modelling. Shafer et al. (2005) identify over 20 "building blocks" of business models in various academic sources. By abstracting them into superclasses, they find out, that a business model consists of three components: firm's core logic, with which it makes assumptions of its environment, firm's strategic choices in a value network, and the means of both creating and capturing value. (Shafer et al., 2005)

Osterwalder and Pigneur (2010) have identified business modelling as a creative technique to create and evaluate possible ways of doing business. They propose that a business model is composed of nine components. Their business model canvas framework (FIGURE 5) uses these components as a communicative tool especially in the business model development process, where different combinations of components are sketched and reviewed by the management of a firm. The easily communicated form of the business model canvas has led to wide acceptance among academic theories and industry practices. A quick glance to the Google Scholar search engine for scholarly literature reveals, that papers and books of Osterwalder and Pigneur from 2002 to 2010 regarding the model have been cited 2169 times (in December 2012).

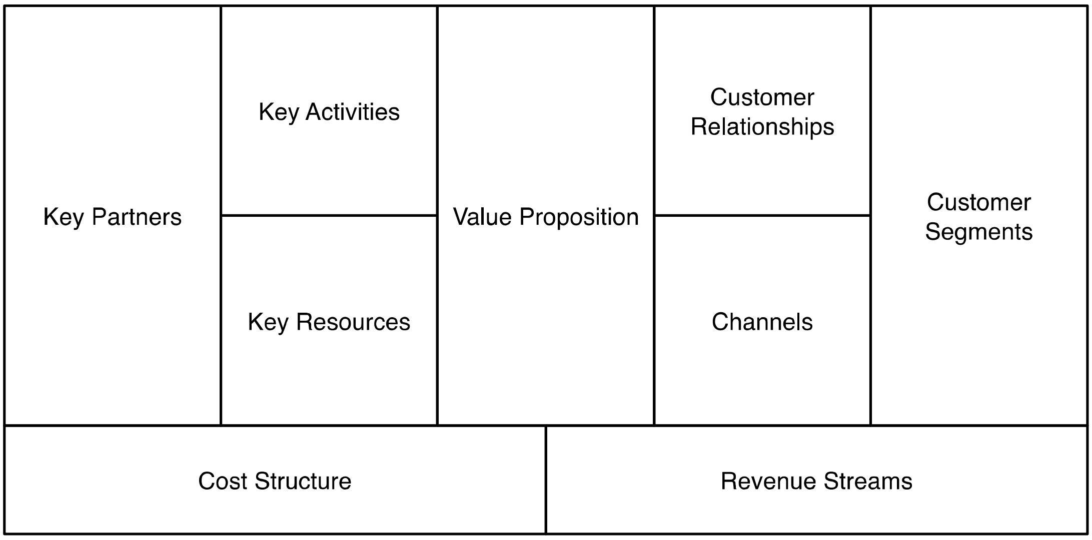

FIGURE 5 Business Model Canvas. Adapted from "Business Model Generation" by A. Osterwalder and Y. Pigneur, 2010.

In the core of the business model is the **value proposition**. The value proposition is the benefit a customer is expecting to have when buying firm's products or services and it solves a problem or fulfils a need a customer is having. A **customer segment** is a set of customers, who share needs and values, and to whom the value proposition is marketed. The value proposition is delivered to customers via **channels** (communication, distribution and sales), which can be either under firm's responsibility or under partners' responsibility. **Customer relationships** describe the level and form of customer involvement with the firm. **Key resources** include tangible and intangible assets, without which the value proposition could not be produced. Similarly, **key activities** include firm's most vital activities and processes that create value. Because no firm operates in complete isolation, **key partnerships** consist of business and governmental partners, who are critical in creating the value proposition. Finally, the financial perspective of the business model covers the **cost structure** and the **revenue streams**. The former represents all the costs that are required to maintain the business model; the latter presents the sources of revenue gained from customer segments. (Osterwalder & Pigneur, 2010)

The business model canvas has been used in scenario construction for its holistic nature and simple presentation (Bucherer & Uckelmann, 2011). In this thesis, it also functions as a unit of analysis, as different hypothetical business models are analyzed and presented.

2.3 Business model innovation and adaptation

Innovative technologies require successful business models in order to become innovations that create value to its users (Chesbrough & Rosenbloom, 2002). Carlson and Wilmot (2006) state: ”innovation is the process of creating and delivering new customer value in the marketplace” (p. 6). Innovation can thus be seen as a combination of an invention or idea and a business model. Firms transform ideas into value-delivering entities, or value propositions, and try to stand out in the competition leveraging the new invention. (Baregheh, Rowley & Sambrook, 2009; Carlson & Wilmot, 2006; Fagerberg, 2004)

Innovations represent one kind of external force that shape firms’ business models and strategies. Sustaining innovations, which are enhancements and extensions of existing innovations and technologies, affect firms’ existing strategies and business models less than disruptive innovations that change whole markets and industries creating new business opportunities and causing business model revisions. (Bouwman, MacInnes & De Reuver, 2006; Cavalcante, 2011)

Cavalcante (2011) identifies four different forms of business model change:

1. Business model creation
2. Business model extension
3. Business model revision
4. Business model termination

In the case of business model creation, an innovation, or more explicitly, a business idea, is *formed* into a new business model. In business model creation, no reference models are used. If the innovation does not require full transformation in firm’s business models, applying firm’s core processes to new business domains, for example, can extend its existing business model. Business model revision is a more drastic form of business model change. As it is presented earlier, disruptive innovations cause market discontinuity, which may lead to reassessment of firm’s strategy. In business model revision, new core processes are introduced into the business model, thus changing the way the firm conducts its business. The last form of business model change is termination. (Cavalcante, 2011) Some firms or even industries may become obsolete, when obsolete technological innovations are replaced by new innovations, and when business models are not adapted and constantly developed (Christensen, 1997).

Holloway and Sebastiao (2010) claim that business models evolve alongside emerging markets. In the case, where a new innovation leads to an emergence of a new market, firms form hypotheses of the future of that market and trial with different business models entailing lower risk level. Entering alliances and contracting partnerships reduces risks. As markets evolve, firms adopt the principles of novel markets and adjust their most effective business models respectively. In addition to this business model effectuation hypothesis, the authors also propose, that firms creating their business models simultaneously try to shape market preferences to their favour. By *driving* the markets, firms try to create a market situation, where they have created the best business model, and the market preferences, standards and conventions have formed around it seamlessly. (Holloway & Sebastiao, 2010)

2.4 Product life cycle

From a marketing perspective, a life cycle is a representation of an entity's evolution, usually measured in sales as a function of time. A well-known application of the life cycle concept is the product life cycle (PLC). By expressing levels of sales in different points of time, a product's life cycle is divisible into distinguishable stages, which Levitt (1965) nominates as:

1. Market development. A product is introduced to market and sales are low.
2. Market growth. The demand and sales of the product take off and grow rapidly while the market expands together with the level of competition. Competition focuses on product and brand.
3. Market maturity. Demand and sales stabilize and competition focuses on price.
4. Market decline. Demand and sales begin to drop and only few competitors exist on the market.

In Levitt's model, the stages form a pattern, in which the growth is exponential at first, but then slows down in late phases of the life cycle, where the market gets more saturated. An illustration of this pattern is an idiomatic S-shaped curve (FIGURE 6).

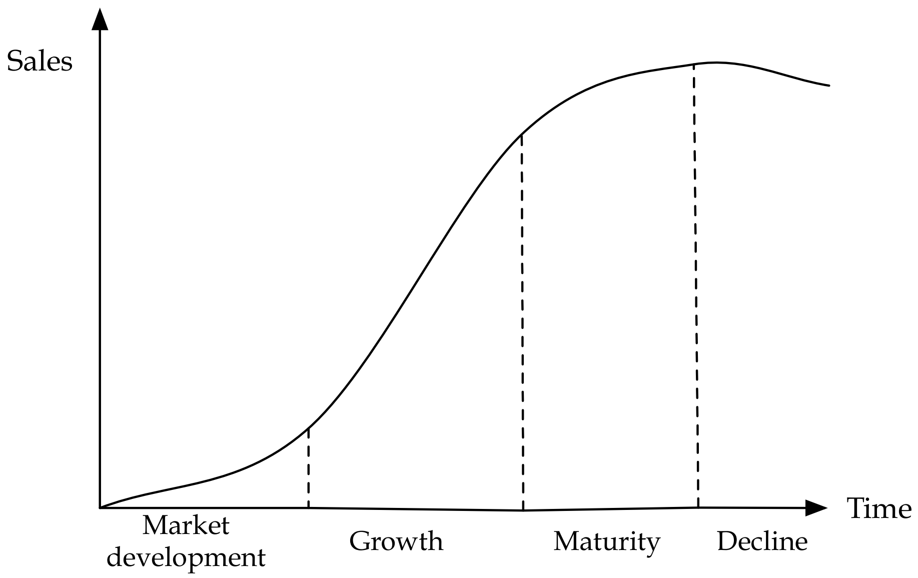

FIGURE 6 The Product Life Cycle. Adapted from "Exploit the product life-cycle" by T. Levitt, 1965.

The product life cycle has a role on firm's strategic level and architectural or business model level. Identifying the stages of firm's own and competitors' products' life cycles helps the firm to identify the position of the products on the life cycle, and furthermore, forecast sales growth or decline and adapt their strategies accordingly. (Levitt, 1965)

When a product is positioned in the decline phase of the PLC, it does not necessarily mean an end to the marketable product. After the decline, the life cycle of a product may experience new growth, thus leading to the continuance of the life cycle. Cox (1967), who uses the same kind of life cycle stage taxonomy as Levitt's, examines the life cycles of ethical drugs. According to him, new growth periods after maturity can often be explained with planned promotional actions, which change the traditional shape of a product life cycle. In addition, Cox (1967) identifies several different curve types for different products' life cycles, although the most prevalent is the shape of multiple sequential S-curves.

The product life cycle concept has been applied to illustrate the evolution of whole industries. Klepper (1997) discusses the patterns in firms entering and exiting specific markets. In the initial stage of product life cycle, firms making an entry to the market are numerous. Ambiguity of customer requirements creates variability in product innovation and new opportunities emerge. In the growth stage, customer requirements clear up, leading to an emergence of a dominant design, or a de facto product. The product innovation declines, but the production process innovation accelerates instead. Less and less firms enter the market and many producers abandon the market while the most process-efficient firms keep up with the pace of growing demand. In the mature stage, market entry diminishes even more and the market leaders produce the evolved de facto standard product. (Klepper, 1996; Klepper, 1997)

A similar approach is presented by Ayres (1987), who proposes an expanding frontiers model of the life cycle. The model explains the classical S-shaped representation of the product life cycle, in which the stages are specified as infancy, childhood, adolescence, maturity and senescence. The model emphasizes an innovative breakthrough in production or R&D that overcomes some technological barrier and starts the product life cycle. Initial, accelerating growth of product sales is a consequence of advancements in technology and subsequently growing commercial and technological opportunities, while decelerating growth in the maturity stage results from diminishing opportunities and market saturation. When a technological barrier is broken, industry's "frontiers" or growth opportunities broaden. (Ayres, 1987.)

Wood (1990) states, that the academic tuition of product life cycle -based models is historically grounded almost equally in Levitt's stage model (1965) and Rogers's model of innovation diffusion (1995), which was originally introduced in 1962. The approach Rogers presents is, however, more applicable to illustrate the evolution of any diffusible entities or phenomena and not just commercial products. In the model, Rogers's (1995) view of product-, or more accurately innovation life cycle, can be seen as customer centric, although the model is purely sociological in a way of not constraining itself by terms like products, sellers or buyers.

2.5 Adoption and diffusion of innovations

Rogers describes the diffusion of innovations as "a process in which an innovation is communicated through certain channels over time among the members of a social system"(Rogers, 1995, p. 5). The theory of innovation diffusion is grounded on an empirical observation, where the diffusion of any successful innovation is slow at first, then takes off and accelerates as more individuals that are new adopt the innovation. As the amount of potential new adopters decrease, the rate of adoption decelerates, until the innovation is considered fully diffused, that is, one hundred per cent of potential adopters have adopted the innovation. Hence, the cumulative growth of the number of adopters can be presented as an S-curve (FIGURE 7), similar to the representation of the product life cycle. (Rogers, 1995)

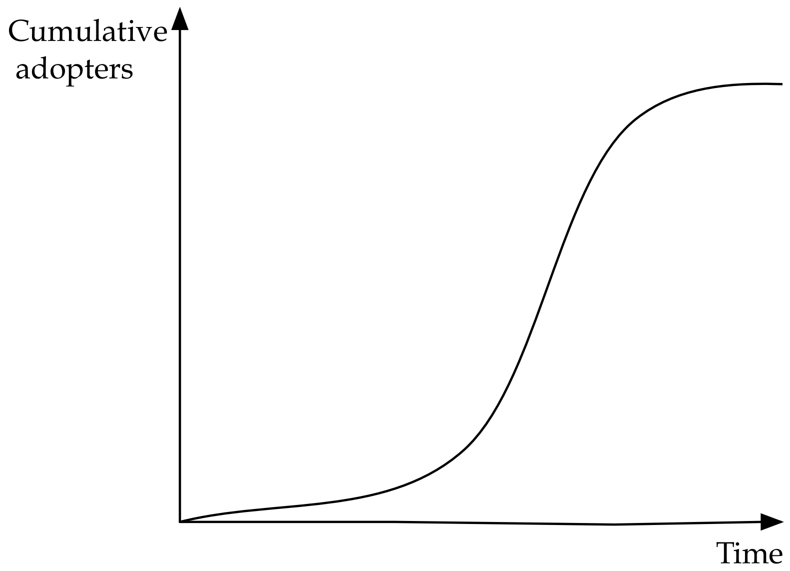

FIGURE 7 The Diffusion Curve. Adapted from ”Diffusion of Innovations” by E. M. Rogers, 1995.

Rogers (1995) states that: ”An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption” (p. 12). Innovations are in principle *contagious* ideas, and the diffusion of an innovation can be compared to a spreading of a virus. Some technological advancement or breaking of a technological barrier starts an epidemic that spreads into the first daring individuals, who later transmit the innovation in form of knowledge to other individuals. This process continues, as long as the number of new adoptions does not rise. Parallels cannot and should not be drawn between adoptions and purchases. Purchases of same innovation can be made multiple times, but an adoption is a one-off event.

It must be noted, that all innovation diffusion processes are not necessarily symmetrically S-shaped or S-shaped at all. Because both adopters and innovations are heterogeneous, rate of adoption, and shape of diffusion curve, differs between social systems and innovations. Also factors, such as innovation attributes, type of innovation-decision, characteristics of the social system, actions of change agents, and communication channels influence the rate of adoption. (Geroski, 2000; Rogers, 1995)

According to Rogers (1995), members in a social system are normally distributed by their innovativeness, that is, the point of time when adopter adopts, or decides to make use of, the innovation. Some adopt the innovation more quickly than the others do. To simplify the analysis of the adopters, adopters are grouped into five categories using standard deviations from the mean value of innovativeness. Thus, each category consists of adopters with quite similar degree of innovativeness. Adopter categories are shown in the figure below (FIGURE 8).

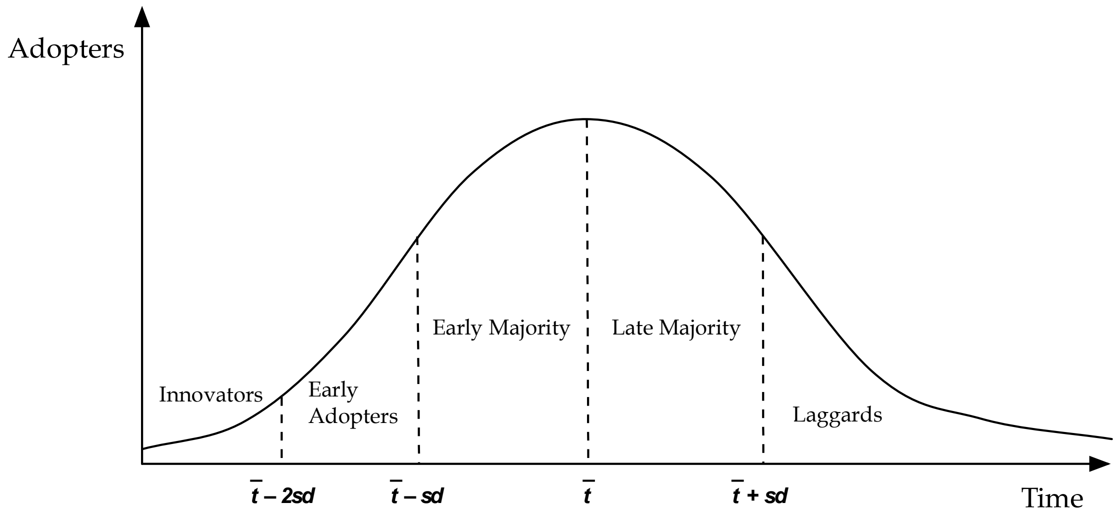

FIGURE 8 The Adoption Curve. Adapted from "Diffusion of Innovations" by E. M. Rogers, 1995.

The first group, innovators, is of smallest size in the social system. However, innovators' degree of innovativeness is the highest of all adopters, which implicates that they adopt the innovation first. The difference between innovators' innovativeness and the average degree of innovativeness is two standard deviations. The second category, the early adopters, is set in one standard deviation away from the average. Within a standard deviation, there are the early majority and the late majority, which, according to Rogers (1995), together comprise over sixty per cent of all adopters. The last adopter category is nominated as laggards. They adopt the innovation the latest and are the most skeptical about the innovation. It is to be noticed, that the categorization excludes all non-adopters. Not all adoptions penetrate the completely social system, and sometimes innovations are rejected or discontinued. (Rogers, 1995)

While all adopters are distinct, categorizing them with innovativeness brings up some additional common characteristics. Individuals in a category may share values, needs and criteria towards innovations and they react to the new innovation similarly (Meade & Rabelo, 2004). Regarding the description of the behaviour and characteristics of certain categories, it must be noted that Rogers treats the categories as ideal types, which instead of being absolute, are based solely on empiric observations (Rogers, 1995).

2.5.1 Innovations

As it is mentioned earlier, all innovations are not identical in nature. Thus leading to variance in the rates of adoption and shapes of diffusion curves between innovations. Rogers (1995) states, that all innovations have comparable characteristics, or attributes which all affect the rate of adoption. Five different perceivable attributes can be identified, which help to describe innovations:

- Relative advantage
- Compatibility
- Complexity
- Trialability
- Observability.

Relative advantage determines whether the innovation actually provides more utility to its user than its predecessor or substitute. Compatibility determines how the innovation conflicts with the adopters' culture, value system and needs. All innovations have a different degree of complexity that determines how difficult an innovation, or its use, is to comprehend by its users. In addition, trialability varies between innovations, because some innovations can be more experimented with than others can. Last, observability determines how the results and the relative advantage of an innovation are visible to other individuals. (Rogers, 1995.)

It has been found that some innovations suffer from network externalities. Network externalities are present, if an innovation is more valuable to its users as the amount of users increase (Mahler & Rogers, 1999). This is especially the case with disruptive innovations, which change the very structure of the market (Christensen, 1997). To overcome such externalities, a sufficient amount of adopters must be gained in order the diffusion process to become self-sustaining. This amount is called critical mass. Until the critical mass of users in this situation is reached, the rate of adoption is slow and the innovation's diffusion does not accelerate much. In some cases, an innovation is rejected and replaced if the critical mass is not fulfilled. Critical mass and network externalities are relevant also in context of interactive innovations, which depend on connectedness of adopters. (Mahler & Rogers, 1999; Rogers, 1995)

2.5.2 Communicating the innovation

As the definition of the diffusion of innovations implies, a crucial component in the diffusion process is communication. Ideas, products and technologies do not reach the completely social system by relying only to innovation originators' efforts. Communicating the innovation to the members of the social system is the first step, but the diffusion depends mostly from the interpersonal communication between adopters. The external influence, which can be considered also as the promotional efforts of the originator, affects the innovators the most. The major part of later adoptions results from interpersonal communication inside the social system. Adopters apart from innovators, or imitators (Bass, 1969), use another adopters as peer individuals thus creating a peer network. Actually, each individual adopter imitates adoption behaviour of individuals with greater degree of innovativeness. In the communication network, knowledge is transferred between already adopted adopters and potential adopters. (Bass, 1969; Rogers, 1995.)

2.6 Technology adoption life cycle

Based on the works of Rogers, Moore (1999) has adapted the diffusion of innovations model to serve as a strategic aid for companies in high technology markets. In the model of technology adoption life cycle, Moore applies the diffusion and adoption of technology products to company's marketing strategy. He proposes that companies should adapt their strategy, as well as their business model, when they move up on the adoption curve. Contrary to Rogers's original theory, Moore's adaptation is based more clearly on a seller's point of view; adopters are buyers and the innovative technology is marketed and sold to them. Moore's major contribution to the diffusion model is the concept of the *Chasm,* which is illustrated as a communication gap between the early adopters and early majority. According to Rogers (1995), such gaps in measuring of innovativeness and between adopter categories have not been empirically verified. The Chasm is indeed hard to validate using the original diffusion model, which abstractly covers all kinds of disruptive innovations. However, the foundations of the Chasm lie in adopters' commercial motivations. As the early market, consisting of innovators and early adopters, and the early majority have very different expectations of the innovation, the early majority cannot use the early adopters as a viable reference, thus resulting in the chasm between the two adopter groups. (Moore, 1999)

In the technology adoption life cycle, Rogers's adoption curve is divided into six phases, all of which the company must go through in order to succeed in the changing market. Each phase requires the company to evaluate and reshape their entire marketing strategy. Innovators and the early adopters form the Early Market. Between the Early Market and the majorities lies the Chasm, on which Moore's first book (Moore, 1999) is concentrated. For the company to overcome the Chasm, Moore proposes a strategy nominated as the Bowling Alley, in which the company starts incrementally selling the technology to the majorities. The next phase, the Tornado, is the phase where a paradigm shift happens; the majority of buyers are starting to favor the new technology instead of the familiar technology. At the top of the adoption curve, there is the Main Street, after which the adoption curve declines back down to the last stage called End of Life. (Moore, 1998) The phases of the technology adoption life cycle are shown in the figure below (FIGURE 9).

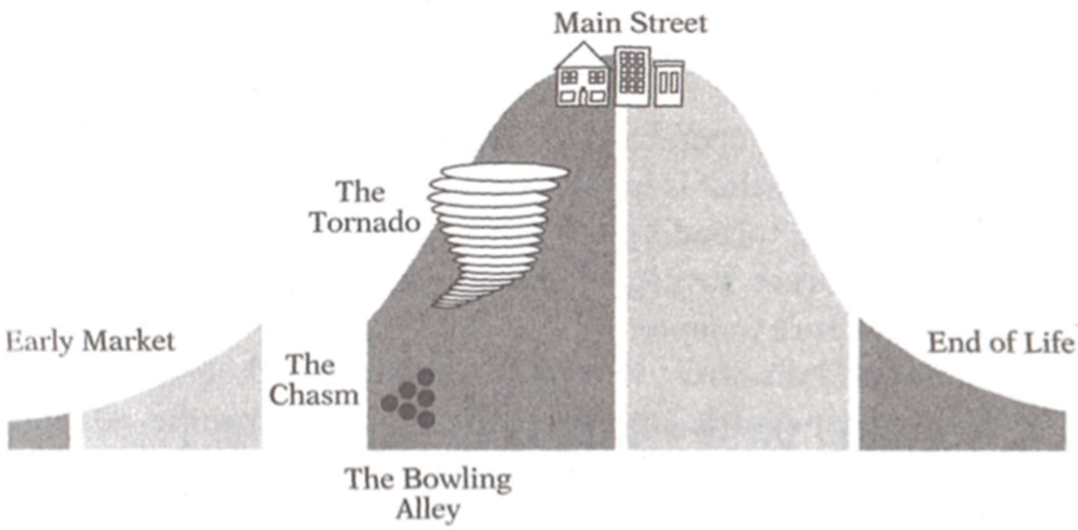

FIGURE 9 The Landscape of the Technology Adoption Life Cycle. Reprinted from "Inside the Tornado" by G. M. Moore, 1998.

In order to understand the implications of the technology adoption life cycle to firm's strategy, and so to business model development, customer behaviour and according marketing strategies must be reviewed first. Treacy and Wiersema (1993) have abstracted competitive strategies into three different strategies, or value disciplines:

- Customer intimacy. Emphasis on tailoring products and services to customers' needs, customer service and relationship marketing.
- Operational excellence. Emphasis on cost leadership, business process optimization and highly efficient use of supply channels.
- Product leadership. Emphasis on product or service quality, innovativeness and continuous improvement of the product or service.

A vital concept used throughout Moore's theory is the concept of whole product (FIGURE 10). The whole product is a combination of core utility, basic product, expected features, augmented features and potential features of the marketed product. (Kotler, Keller, Brady, Goodman & Hansen, 2009; Moore, 1999)

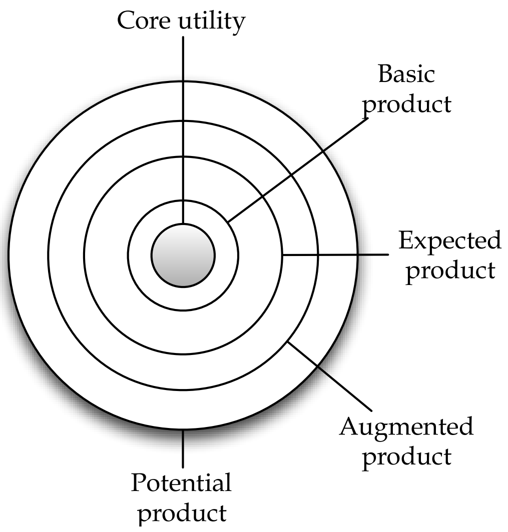

FIGURE 10 The Whole Product. Adapted from "Marketing Management" by P. Kotler, et al. (2009).

The whole product is a hierarchical and layered interpretation of a product from a customer perspective. Each layer adds to the value transferred to the customer. Core utility is the core of the product, and it is the immaterial response to a need a customer is having. Naturally, the core utility is commercialized and sold to the customer in form of a basic product. Expected product incorporates the features the customer is expecting to be included in the product, while it necessarily has nothing to do with the fulfilment of the core utility, but is usually thought to be an integral part of the product. The extra features not expected in the product are part of the augmented product. The last layer of a whole product is the potential product, which signals the customer that the product may offer some new value in the future. (Kotler et al., 2009.)

While these are clearly strategic guidelines, Moore relates them clearly with elements residing in the business model layer. In the next subchapters Moore's diffusion phases and guidelines for adapting company strategy (and actually business models) to them are covered.

2.6.1 The Early Market

The Early market consists of innovators and early adopters. Innovators can be characterized as the most risk-inclined of all adopter groups because they are not able to mirror themselves against another adopters. Innovators are genuinely concerned about new technology instead of its effects on adopter organization's processes. Innovators do not provide much revenue because of the small proportion of all adopters, but they form the most valuable adopter group in gaining access to the next stage of the life cycle. Opinions of the innovators are valuable in the marketplace and, as Bass (1969) expressed, other adopters imitate their adoption behaviour.(Moore, 1998)

Early adopters, on the other hand, do not adopt technology for its own sake, but aim to transform their business by increasing their return on investment with help of the new technological innovation. For both groups it is of importance that the technology is new and unknown for larger audiences. The difference between innovators and early adopters is the scale of investment in new technology. Early adopters invest more aggressively than innovators, because they expect a very high ROI from the innovation. (Moore, 1998)

The key point of marketing to the innovators is to present the innovation to the right people. Especially technology clubs and university projects offer the company the opportunities to introduce, if not the whole product or service, prototypes or even plain models to potential customers who are deeply interested in the technology. Identifying the opinion leaders, i.e., the individuals who influence other adopters' innovation decision (Rogers, 1995), is crucial at this stage. The innovation can be sold straight to the customers in their own environment and using their preferred information channels. (Moore, 1998)

When a sufficient amount of innovators has embraced the innovation, they transfer information about the technology to the Early Adopters. Early adopters, unlike innovators, see the influence the technology could have on their business and furthermore, their position in industry's competition. The right strategy here is to garner enough early adopters and to form tight customer relationships with them. Early adopters expect the technology to be highly customized to their needs, which puts pressure on the company, whose ultimate aim is to offer a standardized product or service. In return, early adopters may invest in the company and help to promote the technology inside the social system. At this stage, all efforts should be concentrated on the product or service and it is functionality. Thus, the competitive strategy in this market is based on the Treacy and Wiersema's (1993) value discipline, product leadership. (Moore, 1998)

2.6.2 The Chasm

As it is mentioned earlier, the Chasm is a communication gap between early adopters and early majority. While adopters in the early market aim to achieve new ways of doing business with the help of the innovation, the majority of adopters want to enhance their current business using the new high technology. Members of the early majority are risk averse and do not invest into new technologies if they or their effects on industry's business are unproven. Staying with the early adopters means that the innovation remains a customizable technology, and these kinds of business relationships are costly. To move beyond the Chasm, innovation originator's strategy must shift from customizing to standardizing, which reduces costs. In addition, companies in the early majority preferably buy from a market leader, because market leaders often create an ecosystem around them, featuring other firms who create products and services around the innovation. That is why the strategy to step across the Chasm is to become one in a well defined market. The key is to choose a small enough market segment, a vertical niche, and to offer them a commercialized product that solves a fundamental problem customers are facing and provides the optimal return on investment (ROI). The size of the first niche is important, because if the niche customer's demand exceeds the marketer's supply, excess demand is left to competitors to fill in. (Moore, 1998.)

To initiate the acceleration in sales and the amount of customer relationships, the company must start the expansion from the first niche, or the bowling pin, following a bowling metaphor. The innovative whole product offering can be marketed to target verticals, which spread the word-of-mouth around the vertical industries. The key to expanding to other niches is the effective use of the first niche, compared to the first bowling pin in a triangle of pins. The company can create more applications around its innovation to same niches, and simultaneously conquer new, closely related niches by slightly altering the whole product offering for each new niche. If pursued correctly, the bowling pin strategy leads to a position, where the same technology architecture can be leveraged in multiple niches from different verticals. (Moore, 1998.)

By offering the whole product, which is new and experiences real demand, the company's strategy has elements from product leadership value discipline; outlined by the vertical industry, the innovation is the superior product in the market. On the other hand, creating a whole product offering for each niche, if with only small changes, conforms to customer intimacy value discipline. Moore proposes that the most desirable strategy is indeed a combination of both. (Moore, 1998.)

2.6.3 Early majority a.k.a. the Tornado

Moving further amongst early majorities, the weight shifts from selling to customers pursuing highest ROI to selling to infrastructural, or technological buyers, who are aware of the new technological innovation, but are careful not to adopt it too soon. When the word-of-mouth circulates inside the adopter category, at some point, they all want to adopt the innovation, because they all want to negate the risk of being the first adopter. This leads to the Tornado, in which demand outweighs supply quickly. The strategy in this phase is to sell as much the technology in volume as it is possible. Lowering the costs by selling the same whole product to all customers simultaneously drives the prices down. Sudden explosive growth in the demand also puts pressure to distribution channels in order them to supply the technology to customers as efficiently as possible. Of Treacy and Wiersema's value disciplines, Moore suggests the combination of disciplines operational excellence and product leadership. While the former is evident, the latter holds still value because if the product loses its superior functionality, high demand creates opportunities for smaller competitors, imitators, to capture remaining market share. (Moore, 1998.)

2.6.4 Late majority a.k.a. Main Street

While the established ecosystem assures company's strong market position, transitioning to the late majority signifies declining demand and stabilizing sales. As Levitt (1965) stated with his product life cycle, is that when sales are stabilizing the competition centers on price. Price competition occurs in the market of large majorities, to whom the commoditized technology is sold with minimal operative costs. As the majorities are risk-averse and conservative, Moore recommends using the same supply channels as during the Tornado. However, in the case of Main Street, where the market approaches saturation, there are no growth opportunities in market penetration strategy, that is, selling existing products to existing markets (Ansoff, 1957). Growth is sought again from the niches, where the competition centers on value instead of price. While the no-frills technology is sold to the majority of market, a product development strategy (Ansoff, 1957) is pursued in the niche markets, where the requirements arise from the end users. The way to answer to these requirements is to use the standard technology as a basis, to which some niche-specific "product + 1" -features are added. (Moore, 1998.)

Moore positions the "product + 1" strategy together within the customer intimacy value discipline, while the continuing use of cost-efficient sales and supply channels are elements from the operational excellence value discipline. These two strategies are used in parallel until the technology yields to a new technology paradigm in the End of Life. (Moore, 1998.)

2.7 Industry evolution in vertical disintegration

The impact of technology adoption life cycle can be connected to vertical disintegration, which has occurred in several high technology industries, such as telecommunications (Li & Whalley, 2002) and vertical software development (Tyrväinen, 2009), for example. Vertical disintegration is a form of firm organization, where some parts of the firm's value chain are outsourced, thus leading to emergence of new actors, providing these outsourced functions to a large customer base cost-efficiently, following the *operational excellency* value discipline.

Tyrväinen (2009) presents a model for evolution of a vertical software industry, which illustrates vertical disintegration, while it also has similarities with the technology adoption life cycle:

1. Innovation phase
2. Productization and Standardization phase
3. Adoption and Transition phase
4. Service and Variation phase
5. Renewal phase

The first phase of the model is the *Innovation phase*, where a firm operating in a vertical industry develops innovative software, which helps the firm automate some of its processes, or otherwise increases the competitive advantage of the firm. In this phase the firm invests a great deal in both technology and human capital required to develop the software. Then, in the *productization and standardization phase*, competing firms in the vertical industry start copying the best practices to their own software systems, as the competitive advantage proves prominent, thus leading to emergence of standards. To gain competitive advantage over the industry's market leader, competitive firms participate in further standardization activities and form micro ecologies around the standards, using common interfaces. Software products also start to emerge around these interfaces, as the same product can be sold to several firms in the industry. In the *adoption and transition phase* the firms developing their own software start outsourcing SW development and adopt a competing technology product and standards. In the fourth phase, the *service and variation phase*, one standard is accepted as a dominant design as most firms in the industry adopt it. This dominant design directs vertical software providers to implementing the de facto standard and interfaces. As the interfaces develop towards interoperability and uniformity, diffusion of related technology within the industry accelerates. Last, in the *renewal phase*, a new source of competitive advantage emerges, and some actors start to develop in-house software to pursue that advantage, thus leading to another cycle in the evolution. (Tyrväinen, 2009.)

The model emphasizes the role of common interfaces in creating demand and adoption of software technologies. The innovation phase reflects the needs of Moore's *Early Adopters*; they need customized technology, which brings them competitive advantage. However, the innovation is communicated to vertical competitors, and technology companies pursuing economies of scale emerge to provide the technology to the vertical enterprises. The emergence of common interfaces and a dominant design dictates, whether the technology falls into the Chasm or not. Thus, the developing of standards and common interfaces are network externalities impacting the critical mass of adopters. In the productization and standardization phase vendors of vertical-specific technology branch out to other verticals, as the first vertical market gets saturated, thus leading to Moore's *Bowling Alley* -strategy.

Micro-ecologies have a strong impact on the diffusion of technology in the vertical software industry. It is the survival of the fittest and user acceptance, which together determine the eventual dominant design. The vertical software industry disintegration model bears similarities to the industry life cycle model. Both models state, that during industry boom, the amount of firms increases rapidly, and start to center around standards and de facto technologies. It must be noted, that the competition between these standards-driven micro ecologies may then both increase the amount of companies in the industry, because disintegration creates new business opportunities for new entrants, and decrease the amount of companies because of mergers and acquisitions.

2.8 Integrating the lifecycle and business model concepts

As the Internet of Things starts to find its shape, firms participating in the emerging market formulate new strategies and business models. Efficient business models can be found by trial and error, as Holloway and Sebastiao (2010) propose, but to limit the amount of possibilities to the most promising business models requires consideration of several factors. Firms should anticipate the changing factors of the future market early enough in order to gain a market position that remains until the maturity of the technological cycle and possibly beyond it to the next paradigm, and, as Moore suggests, adapt their business models to the innovation life cycle.

Using the knowledge about innovation life cycles, companies can develop long-term strategies in which the factors of changing demand are built in. One way of strategic planning is to integrate the concepts of innovation life cycle and business model change into a matrix (FIGURE 11), where business models once created, are positioned in correct stages of innovation life cycle.

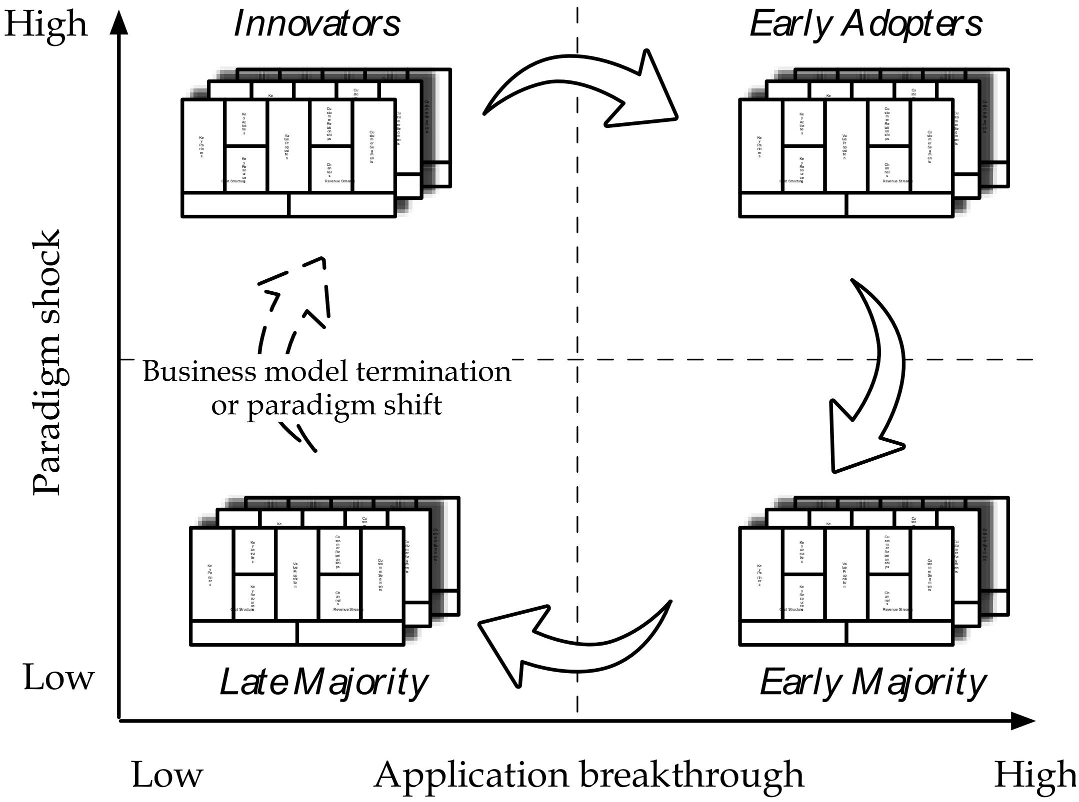

FIGURE 11 Business model life cycle. "Adapted from Inside the Tornado" by (Moore, 1998).

Composing a business model portfolio consisting of alternative business models for each life cycle stage is a long-term strategy, spanning the entire life cycle. In the first stage, finding the asset combination to form the superior value proposition to innovators are of greatest importance. After the innovation begins diffusing, the business models are changed as the strategy changes. Shifts between the stages may require business model changes of different scales, from business model revision to creation or termination. At the end of the life cycle, business models face the threat of termination; while the technology matures and is made obsolete by a new paradigm shift, new entrants and old companies transforming their entire business challenge the established roles and market positions.

3 Method

3.1 Futures research

Futures research is a multidisciplinary science that aims to describe, explain and understand large societal phenomena and related processes on the basis of knowledge of the past and the present. Thus, the empirical subject of futures research is actually the present. Futures research is not a research method, but it synthesizes methods from different sciences and disciplines.

As Bell (1997) states: "Futurists explore alternate futures–the possible, the probable and the preferable (p. 42). " On the basis of knowledge about current trends, regularities and other data, justifiable assumptions, or *proferences*, of the future can be made. In order to be scientifically valid, a proference must be consistent with the empiric understanding of the present, and based on theories, models and explanations produced by different sciences. Proferences of the future can be seen as possible futures, some of which are preferable, some undesirable. Futures research uses proferences to structure the future and express plausible futures. (Bell, 1997.)

Business-related incentives for conducting futures research are apparent; using forecasts of the future, firms can make decisions regarding future market factors, and claim competitive advantage, if the forecasts are valid. A type of a deliverable of a futures research is a guideline leading to a plausible future. A guideline is a set of actions, with which a firm can anticipate the future and contribute to the development of the future.

3.2 Evolutionary paradigm and the systematic research approach

Studying the evolution of societal systems, including businesses, in the brink of a new technological revolution requires an evolutionary approach towards the future. Mannermaa (1991) introduces a research paradigm for evolutionary futures research. The paradigm builds on six postulates, which are summarized as following (Mannermaa, 1991, p. 238-257):

1. Societal systems are dynamic, nonlinear systems, of which components are based on people, groups of people, and physical and intellectual products. These systems have interfaces with other systems and the nature. Societal systems develop on their own organizational level. They cannot be derived from the actions of people, while they are a product of peoples' actions.
2. Central societal processes are irreversible, which leads to a temporal asymmetry between the past and the future of a society.

3. Self-organizing development of societal systems contains both relatively predictable phases of stable development and phases of revolutionary development, which are unpredictable, and create either new possibilities of stable development or collapsing of a society.
4. Evolution of societal systems has a tendency towards increasing complexity, and growth of more effective information, energy and material streams.
5. The evolution of societal systems is emergent. New higher-level systems with unique attributes are born in the interaction between different systems in different stages of evolution.
6. The empirical research subject of the evolutionary futures research in the present is a multiversal whole composed of several perceptions of reality.

A business can be seen as a formal system, including components, subsystems, processes, interaction interfaces, and both physical and abstract resources. Businesses are parts of larger systems, such as value networks, and their management in the market can be measured. A business is also a social system composed of people, their interactions and human capital. According to the third postulate, the evolution of systems contains stable phases followed by unpredictable revolutions. These revolutions may be disruptive, technological innovations, which alter the way businesses and people act. After the technological paradigm shift has occurred, the former state cannot be backtracked into (postulate 2). The increase in complexity and information streams (postulate 4) is observable in the context of technological innovations; the development of the Internet, for example, has created a new information age, where organizations, relationships, objects and now even physical things become more complex. Thus, also new levels of complexity and systems with emergent attributes are results of increasing complexity; the IoT has unique attributes, which cannot be explained the attributes of lower-level systems (postulate 5). Finally, postulate six summarizes the nature of futures research by noting, that the conception of the reality is multiversal, which means that the reality can be seen from different subjective viewpoints. (Mannermaa, 1991.)

Can a business model, then, be seen as a formal system? Checkland states, that a system S is a formal system if and only if (as cited in Mannermaa, 1991):

1. S has a meaning or a mission.
2. S has a meter of success, indicating progress or regression.
3. S includes a decision making process, with which it can control its operations.
4. S includes components fulfilling the requirements of a system and having the same features of S.
5. S includes components, which interact with each other, enabling a flow of actions through the system.
6. S can be included in larger systems and/or environments, with which it interacts.

7. S has boundaries set by the area, where the decision making process is in effect, and separating S from 6.
8. S has physical and abstract, human-related resources usable by the decision-making process. (p. 268–269)

A business can indeed be seen fulfilling the requirements for formal systems. Businesses have a meaning, or a mission, and it is to create value, as it is expressed in chapter 2. The success of a business can be metered (very simplifying) with a truth-value: is value created or not? Of course, many other indicators, such as key performance indicators (KPIs), exist and are clearer than that. A business model also implicitly includes a decision making process, involving the transformation of resources to value and profit. The fifth criterion is fulfilled in business models themselves, because a business model is a deconstruction of a business to its systemic components and relationships between them. Businesses have both interfaces towards other businesses and different levels of systemic hierarchy, such as value networks or ecosystems. These connections are inclusively present in business models. Finally, a comprehensive business model lists both abstract and material resources needed to produce value.

3.3 SSM and Mannermaa's adaptation to paradigm

Conforming to the evolutionary paradigm, Mannermaa (1991) proposes a qualitative research methodology for systemic futures research by adapting Checkland's (1985) Soft Systems Methodology (SSM), which was originally developed for solving nebulous, abstract, human-related real-world problems using methods from physical systems engineering.

A methodology is not a method, but a *system of methods*, and targeted to a specific area of interest. The modified SSM methodology includes elements and actions to comply with the paradigm for evolutionary futures research. By analyzing the system and factors affecting it at the present, relevant, possible future states of the system can be envisioned, as well as the actions leading to them. (Mannermaa, 1991.) The modified SSM methodology appears to be coherent with the future-oriented research objectives of this thesis, and moreover, it provides a structure to assess the value networks and MNOs' business models in the future IoT. Mannermaa's future-oriented adaptation of the SSM is presented in the figure below (FIGURE 12):

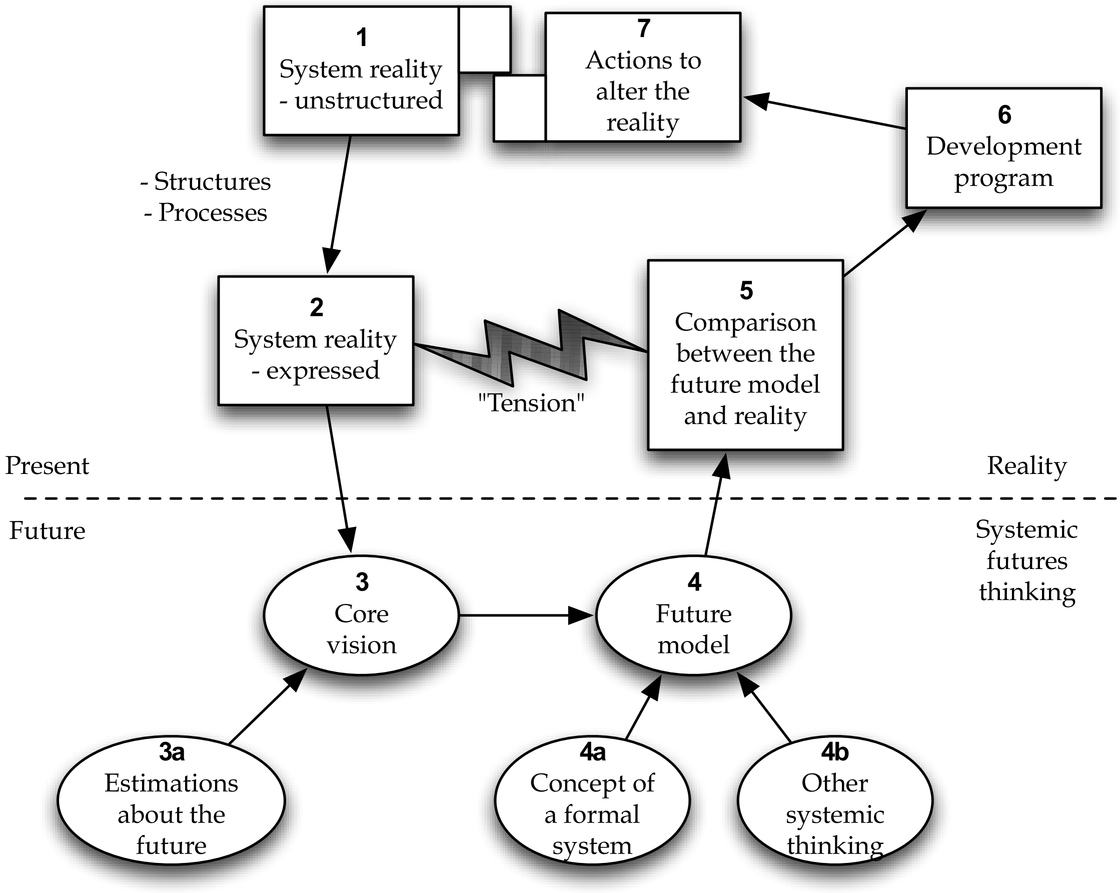

FIGURE 12 Soft systems methodology in futures research. Adapted from "Evolutionaarinen tulevaisuudentutkimus" by M. Mannermaa(1991).

The methodology can be structured as a process of five stages:

1. Describe the reality of the decision-making system (stages 1 and 2 from figure 17)
2. Identify core visions of relevant systems (stage 3)
3. Formulate and test future models (stage 4)
4. Compare the future models and the reality (“diagnostics”) (stage 5)
5. Formulate a development program to alter the reality (stage 6 and 7)

As a starting point, the reality of the system is described. The structure and process of the system and mutual relationships between them are analyzed, after which a relevant view of the system at the present is presented. The viewpoint, from which the system is inspected, is decided in this stage, while different perspectives on a system exist, as it is explained in the sixth postulate of the evolutionary paradigm. (Mannermaa, 1991.) The unit of analysis, id est. the system in this thesis, is an abstraction of an MNO and its business model elaborated in chapter 4. The system reality is constructed by synthesizing academic research data and public data about MNOs from public reports and corporate websites. The aim is to construct a system representing a generalized MNO's business model.

In the second phase, core visions of the system are identified and formed. A core vision is a collection of hypotheses, which forms the basis of plausible futures. Forming core visions requires estimations regarding the system and its environment. When change is studied, several core visions can be proposed to specific stages of change process. (Mannermaa, 1991.) To construct core visions of an MNO in the IoT, the implications of the IoT and its technologies must be taken into account, as well as the customer preferences and societal factors. The change-factor is also embedded in the theory of technology adoption life cycle, which is used as the theoretical basis of this thesis. Thus, it is worthwhile to structure core visions to each future stage of the technology adoption life cycle. While the technology adoption life cycle model is generalized from empirical studies, it provides a base for educated conclusions concerning the future development of the IoT and MNOs' role in it.

The third phase entails the construction of future models, which follow the core visions created in the previous phase. A future model is a description of actions needed to achieve the state represented by each core vision.(Mannermaa, 1991.) Looking the future models from a perspective of business and business models particularly, the key variables in future models are the components of the BMC.

Mannermaa emphasizes, that testing the validity of future models is problematic, because there are no correct or incorrect future models, only more or less justifiable, and each model reflects the researcher's unique view on the system reality. Future models can, however, be validated by assessing their conformity to the concept of a formal system. (Mannermaa, 1991.)

In the fourth phase, the constructed future models are compared with the reality at present. As the future models show possible states of the business in the future, along with possibly changed structures and new activities, changes, or targets of development, are identified. These changes should be both "systemically desirable and culturally feasible in the particular situation in question" (Checkland, 1985, p.764). Comparison should also elicit discussion in the organization, revealing structural, procedural or attitudinal change opportunities. (Mannermaa, 1991.)

The aforementioned change propositions are structured into a development program in the last phase. The development program consists of concrete actions to cover required changes, their prioritizing and justification, and motivating the stakeholders of the organization in question. (Mannermaa, 1991.)

4 The Internet of Things as an innovation

The Internet of Things (IoT) is an emerging technological paradigm, where physical objects are connected to the communications and storage infrastructure of the Internet (ITU, 2005). The main objective of connecting things to the Internet is to gather either real time or right timed information of physical objects and their environment, process it and make it available to people, business processes, web services or other physical objects (Mattern & Floerkemeier, 2010; Uckelmann et al., 2011a). The vision behind the IoT is not new, while the same principles have been applied to concepts such as pervasive or ubiquitous computing and ambient intelligence (Fleisch, 2010; Wright, Gutwirth, Friedewald, Vildjiounaite & Punie, 2008). However, technological advances in machine-to-machine (M2M) communications, embedded processor technology, nanotechnology and low-cost wireless communication are facilitating the current emergence of the Internet of Things (Atzori, Iera & Morabito, 2010).

Several notions of the term "Internet of Things" were articulated at the turn of the millennium alongside the development of Radio Frequency Identification (RFID) technology, conducted particularly by The Auto-ID Labs. Together with standardizing organization GS1, they began developing the EPCglobal architecture framework for RFID networks leveraging on the Electronic Product Code (EPC) as the unique identifier. (Atzori et al., 2010; autoidlabs.org, 2013; EPCglobal, 2013.)

Despite the fact that the term Internet of Things has formed alongside the development of RFID and EPC-technologies (Haller et al., 2009), technology independent views on the definition of the IoT have emerged. Van Kranenburg et al. (2011) outline the Internet of Things "as the superset of all objects that are uniquely identifiable by electro-magnetic means and for which it is possible to specify a semantic and/or behaviour" (p. 10). Haller, Karnouskos and Schroth (2009) define the IoT as "A world where physical objects are seamlessly integrated into the information network, and where the physical objects can become active participants in business processes. Services are available to interact with these 'smart objects' over the Internet, query their state and any information associated with them, taking into account security and privacy issues." (p. 15). As the former definition follows a rather things-oriented approach (Atzori et al., 2010), the latter gives a more comprehensive definition of the scale of the paradigm. The most comprehensive definition of the IoT is given by Uckelmann, Harrison and Michahelles (2011a):

> "The future Internet of Things links uniquely identifiable things to their virtual representations in the Internet containing or linking to additional information about their identity, status, location or any other business, social or privately relevant information at a financial or non-financial pay-off that exceeds the efforts of information provisioning and offers information access to non-predefined participants. The provided accurate and appropriate information may be accessed in the right quantity and condition, at the right time and place at the right price. The Internet of Things is not synonymous

> with ubiquitous / pervasive computing, the Internet Protocol (IP), communication technology, embedded devices, its applications, the Internet of People or the Intranet / Extranet of Things, yet it combines aspects of all of these approaches." (p. 8.)

Thus, the IoT is a larger entity, than any information system or technology. It is an innovative paradigm in a philosophical sense, changing the way of operating in societal systems. As a technological paradigm, the IoT cannot be expressed by using certain technologies, such as RFID, which act only as enablers for the future IoT (Atzori et al., 2010; Haller et al., 2009).

4.1 Technological foundations of the Internet of Things

The IoT vision emphasizes on the importance of interoperability and multipurpose smart objects, which use open, standardized communication protocols. In the following subchapters some of the basic technologies are investigated and detailed.

4.1.1 Identification and wireless sensor networks

Identification technologies, such as RFID, form the base of the IoT, because they enable the addressing of objects in networks. Radio Frequency Identification (RFID) is a short-range, wireless communications technology, which is designed for embedded communication for physical objects. RFID technology makes it possible to uniquely identify objects remotely by attaching small RFID transponders, or tags, into the objects. Tags can contain data, such as the Electronic Product Code (EPC) or an IP address. The data in tags is read with RFID readers, which in turn are connected to networks. Equipped with an RFID tag, an object can be identified uniquely in a network, it can communicate its identity to another objects, services or humans, and it can store its context (Cvijikj & Michahelles, 2011). Data associated with each physical object can include object's place of origin, previous owner, or virtually anything. This data-object association creates a virtual representation of the physical object in the virtual world, where it can be accessed using services in the Internet. As fundamental components of the IoT, these objects are considered to have capabilities of both physical and digital objects (Mattern & Floerkemeier, 2010).

While RFID-technology is applied to basic physical items, the things connected in the IoT contain also more functional objects, which, similarly as RFID tagged objects, are identifiable but also have more capabilities in networking, information processing and sensing (Kortuem, Kawsar, Fitton & Sundramoorthy, 2010; Want, 2004). These objects can operate autonomously, id est. without human interaction, on the basis of input from applications in the network. Wireless sensors are an example of these *smart objects*, which sense their environment and upload the sensed data at a request from applications. According to Sánchez López et al.(2012), "Both RFID and sensor technologies are key enablers of the

IoT because they provide means to identify objects and to obtain their condition." (p. 293). Furthermore, Bohli, Sorge and Westhoff (2009) consider the provision of sensory data as a dominant service in the future IoT. Therefore, wireless sensors are seen as key components of the IoT, because with sensor technology, environmental factors of connected objects can be monitored remotely, and with the data connected from multiple sensors, comprehensive contexts can be synthesized to demanding services. Sensors can also be equipped with actuating functionalities, which enable them to alter the object's behaviour or the environment on the base of sensory data. Wireless sensor (and actuator) networks (WSNs/WSANs) are networks of sensors/actuators, which sense features of their physical environment, send the data into a network, and in the case of WSANs, alter the environment accordingly. (Luckenbach, Gober, Arbanowski, Kotsopoulos & Kim, 2005.) WSAN technology can be applied to remote HVAC, energy and security management in buildings, for example, where sensors monitor the building's context attributes, such as temperature, and change the behaviour of controlling devices accordingly. One view on the mission of the IoT is to integrate different WSNs and WSANs into a single infrastructure, where all sensors are part of the global IoT. Several propositions for technological integration are presented, especially under the European Union's Seventh Framework Programme (FP7). The European SENSEI project proposes architectural and middleware specifications for integrating heterogeneous WSAN islands to the Internet of Things, and increasing interoperability and enabled services (Carrez et al., 2008).

However, the Internet of Things vision does not specify the means of connecting objects into the Internet. Because of immeasurable sensor technologies and smart objects, middleware technology is required to enable the development of truly open sensor-based services in the IoT. With a middleware layer between applications and smart objects, object-specific details can be abstracted, removing the need of application developers to have knowledge of industry-specific details of sensors and smart objects (Atzori et al., 2010; Emmerson, 2010). The SENSEI project (Carrez et al., 2008) also acknowledges the role of middleware platforms, which interface between sensors and applications, providing sensors' functionalities as technology-agnostic resources. In the SENSEI architecture, real-world objects are presented towards the application layer as conceptual resources, which are identified using URIs and interacted with methods, adhering to the RESTful paradigm. (Carrez et al., 2008.)

4.1.2 Machine-to-Machine communications

Diffusion of Machine-to-Machine communications (M2M) is a step towards the IoT already taken. The terms M2M and IoT are often, but incorrectly, used interchangeably in both research and business literature. OECD (2012) mistakenly associates the IoT to networked, *passive* physical objects embedded with RFID-technology, whereas M2M is associated with *active* devices connected to the Internet. In the IoT-A architecture specification (Bauer et al., 2013), M2M is defined as a means of communication between networked machines, which can operate autonomously on the basis of machine-generated information. As the costs of M2M communications have been lowering, vertical industries have adopted M2M solutions. Companies have discovered the use of machine-generated data in business processes, which brings cost-reductions by eliminating manual business processes, and additional revenues by enabling value-added services and product differentiation to customers (Vodafone, Circle Research & Hilton, 2013).

The term M2M is especially used in the telecom industry, where the view has shifted along with technological evolution from handsets communication to communication between independent machines without human interaction. Because of large, established M2M communications business and technology, RFID-readers, intelligent sensors, and embedded computers of the future IoT are most likely connected to the Internet with these M2M-technologies. In one perspective, both M2M-devices and physical objects can be seen as the components of the IoT and as things in the IoT (Haller, 2010). Thus, both M2M-networks and connected physical things, whether they are active or passive, belong in the domain of the IoT.

M2M development business is concentrated in two main areas: M2M modules and devices, and M2M platforms. While the modules can be connected to networks without platforms, just communicating data, M2M platforms are software platforms, which augment the connected modules with value-added services, such as connectivity support and device management.

M2M communications is highly driven forward by the telecommunications sector, where MNOs provide the communications infrastructure needed for wireless communications. A large number of M2M standards have emerged to support the emergence of the IoT (see for example Atzori et al., 2010). The European Telecommunications Standards Institute (ETSI, 2011) proposes a functional high-level architecture for M2M, which consists essentially of two domains: the device and gateway domain and a network domain (FIGURE 13).

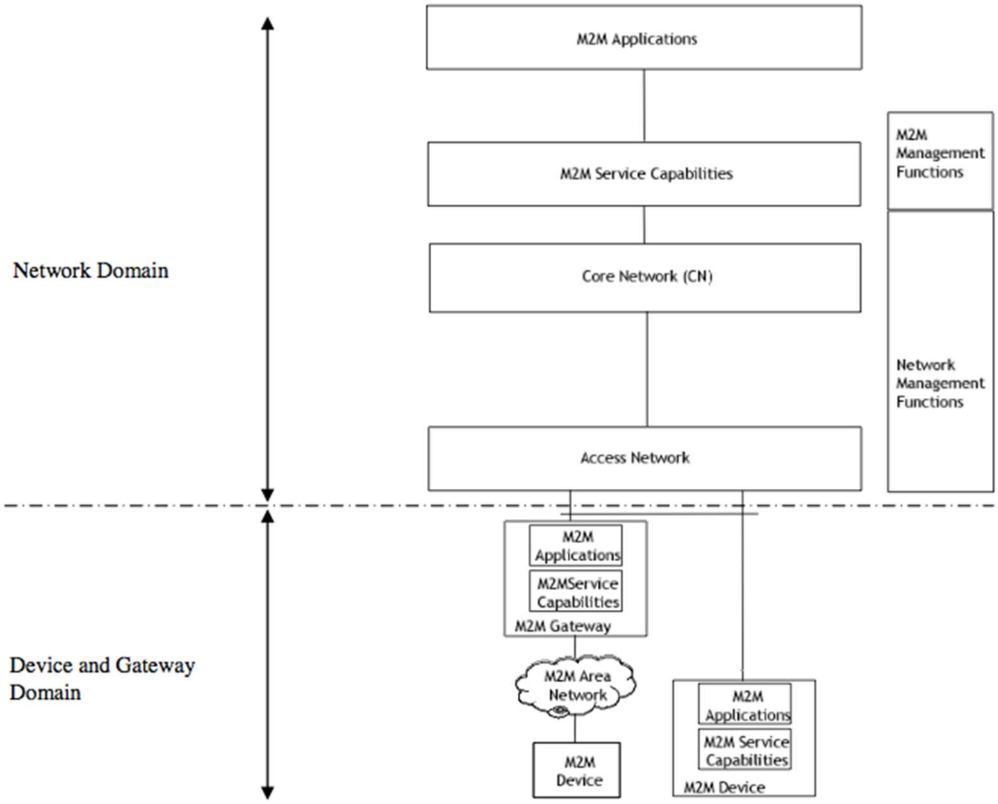

FIGURE 13 High-level architecture for M2M. Reprinted from "Machine-to-Machine communications (M2M); Functional architecture" by ETSI, 2011.

M2M devices are positioned in the device and gateway domain, and can either be connected to the network domain via an M2M gateway or directly. Access networks connect M2M devices and gateways to core networks, which are owned by network operators. The key part is played by the M2M service capabilities, which act as a layer between the core network and applications providing the required functionalities through open APIs. Service capabilities include application enablement, remote entity management, security, and transaction management, among several others. (ETSI, 2011.)

The ETSI architecture above implicates changes to MNOs business, because not all the devices are directly addressed by SIMs. Introducing M2M middleware to the communication chain brings elements from adjacent ISP business.

4.1.3 Web of Things

While the RFID is a means of identification and M2M technologies enable autonomous communication of the data, the IoT also contains applications and services using the data and communications networks. While things can communicate with each other via M2M-networks, also human users should be able to communicate with them via applications (M. Wu et al., 2010). According to Uckelmann, Harrison and Michahelles (2011a) the IoT is likely to be affected by the Web 2.0, which helps connecting the machine-generated data to user-generated data. Integrating the functionalities of the Web 2.0, or the Social Web, to the IoT results in a vision called the Web of Things (WoT), where things can be, for example, indexed and searched by search engines and recommended to another users via social media (Atzori et al., 2010; Guinard, Trifa, Mattern & Wilde, 2011).

In the WoT, sensors and actuators in WSANs and smart objects are seen as web services, which can be accessed via user interfaces in the web, thus enabling the use of M2M functionalities with mobile phones or personal computers. Representational State Transfer (REST) is an approach of integrating WSNs and smart objects into the World Wide Web. Using REST, each smart object, or sensor, is seen as a resource with a URI, through which the resource is used with HTTP-like methods, such as GET, POST and PUT. Efforts have been made to apply RESTful architectures to intercommunicating WSNs with appropriate protocols accommodating to low processing and energy requirements of wireless sensors. (Castellani et al., 2010; Guinard, Trifa, Karnouskos, Spiess & Savio, 2010; Guinard et al., 2011; Luckenbach et al., 2005) Furthermore, to supplement HTTP protocol, the IETF CoRE working group has developed the Constrained Application Protocol (CoAP) standard for power-confined, networked objects, such as wireless sensors, and their RESTful use in the WWW (Shelby, Hartke & Bormann, 2013).

The Web of Things sets requisites for middleware technology in the future IoT. M2M application platforms should also be capable of intermediating between proprietary protocols and Web-protocols to enable the transition from Intranets/Extranets of Things towards the Internet of Things. In the ETSI architecture, the service capabilities layer provides this interoperability, and may be implemented in cloud platforms. However, a middleware gateway approach is also presented in the ETSI architecture, which may serve as a complement or a substitute for M2M application platforms. An M2M gateway acts as a middleware, and is the only connection to the operator's network. In this case, M2M modules using short-range, constrained protocols do not have to be equipped with SIMs and multiple connection interfaces. In network operator's point of view, the M2M gateway bundles several M2M connections into one, and reduces costs related to connectivity management and application platform usage. (Weldon, 2012.)

4.2 Applications and services

Applications following the IoT-vision are implemented in different vertical sectors, where wireless M2M technology can be used in value creation. In the following table (TABLE 1), common vertical use cases are listed along with example applications.

TABLE 1 Example M2M use cases with wireless WAN coverage and mobility support. Reprinted from "M2M: From Mobile to Embedded Internet", by Wu, Talwar, Johnsson, Himayat and Johnson (2011).

Security and public safety	Surveillance systems, control of physical access (e.g., buildings), environmental monitoring (e.g., for natural disasters), backup for landlines
Smart grid	Electricity, gas, water, heating, grid control, industrial metering, demand response
Tracking and tracing	Order management, asset tracking, human monitoring
Vehicular telematics	Fleet management, car/driver security, enhanced navigation, traffic info, tolls, pay as you drive, remote vehicle diagnostics
Payment	Point of sale, ATM, vending machines, gaming machines
Healthcare	Monitoring vital signs, supporting the aged or handicapped, web access telemedicine points, remote diagnostics
Remote maintenance and control	Industrial automation, sensors, lighting, pumps, vending machine control
Consumer devices	Digital photo frame, digital camera, ebook, home management hubs.

Currently, these different vertical solutions can be considered as technological islands, isolated by proprietary communication and identification technologies. M2M solutions offered to firms and industries are tailored to meet the needs of each participant.

M2M communications can be used in security applications. Surveillance of assets, work sites and employees (Verizon Enterprise Solutions, 2013) can be enhanced with M2M communications and integration with company's IT. In the B2C sector, home monitoring and security services, such as Verizon's service for home controlling, enables residents to monitor their homes and lock their doors remotely. Close to security domain is tracking of items, for example in case of stolen or lost mobile phones.

Smart electricity meters have been started to deploy globally (GSMA, 2013), while concerns for increasing energy consumption and energy saving are growing. Utilities consumption, such as electricity or water consumption, can be monitored using smart meters, which send the consumption data wirelessly on specified intervals to an M2M server, which in turn is connected to services of the service provider via mobile networks. In addition to removing manual work, smart grids help balancing the utilities supply with demand fluctuations. (G. Wu et al., 2011.)

Remote maintenance and control is closely related to smart utilities services and building automation. The drivers of more intelligent building automation are both economical and ecological, because better energy efficiency can be achieved by using automatic sensors and actuators.

Vehicle telematics refers to connected vehicles, which can be remotely monitored by service providers, car manufacturers or other businesses. In B2B-markets, connected fleet management enables tracking of company's vehicles (Lucero, 2010). Vehicles embedded with sensors and automatic communication capabilities can automatically call for emergency in cases of technological failure or accidents (Deutsche Telekom, 2012; GSMA, 2013).

Payment applications using M2M communications have been around for many years. Payment terminals use cellular networks, which increases convenience and security, when buyers can use their credit and debit cards nearly wherever. Furthermore, the proliferation of Near Field Communication (NFC) payments drives the mobile payment business even further (GSMA, 2013).

Connected healthcare is another emerging application of the IoT. Telephony combined with remote monitoring of human vital conditions can prevent deaths and severe conditions, if, for example, patients suffering from long-term conditions or elderly patients can be treated remotely(GSMA, 2013; OECD, 2012; Sundmaeker, Guillemin, Friess & Woelfflé, 2010). Especially in countries with rapidly aging population, the value of assisted living increases. One use case could be the case of a patient suffering from heart conditions. A connected bracelet sensing patient's pulse sends an alarm to a hospital, if the patient's pulse shows signs of a heart attack. Another use case is a telehealth self-service station, where people can measure their health parameters, sending the data to remote hospitals. Thus, the need to travel to health centers, possibly inaccessible in rural areas, is reduced.

Consumer electronics and media markets have kept up the pace with the technological improvement of communication technologies. In addition to computers and mobile phones, connected consumer devices include gaming consoles, cameras, E-book readers, and the spectrum of connected devices widens. A smart home, (also connected home(Intellect, 2011)), is a concept, which integrates smart objects into a single household into a conceptual entity. In a smart home, services can be used via the Internet. Household devices, such as entertainment devices and kitchen appliances can be interacted with a residential gateway (Hofrichter, 2001), which serves as a hub of connected home services. Verizon's (2013) home controlling and monitoring service is close to a complete commercial smart home value proposition, but the solution leaves the household in separation of vertical services described in the Intellect Connected Home report (2011).

It is inevitable, that these different vertical M2M applications have different requirements concerning communication technologies; some applications require gathering of data from a wide geographical area, while others are limited to a single room. Devices connected to mobile networks, or wireless wide area networks (WWANs), require no physical connection to the network, and are capable of covering large geographical areas (Gonçalves & Dobbelaere, 2010). In the case of geographically concentrated applications, local and short-range technologies, such as WLANs or WPANs, suffice (Prasad, Schoo & Wang, 2004). In the next figure (FIGURE 14), some M2M use cases are classified according to their geographical dispersion and mobility (OECD, 2013).

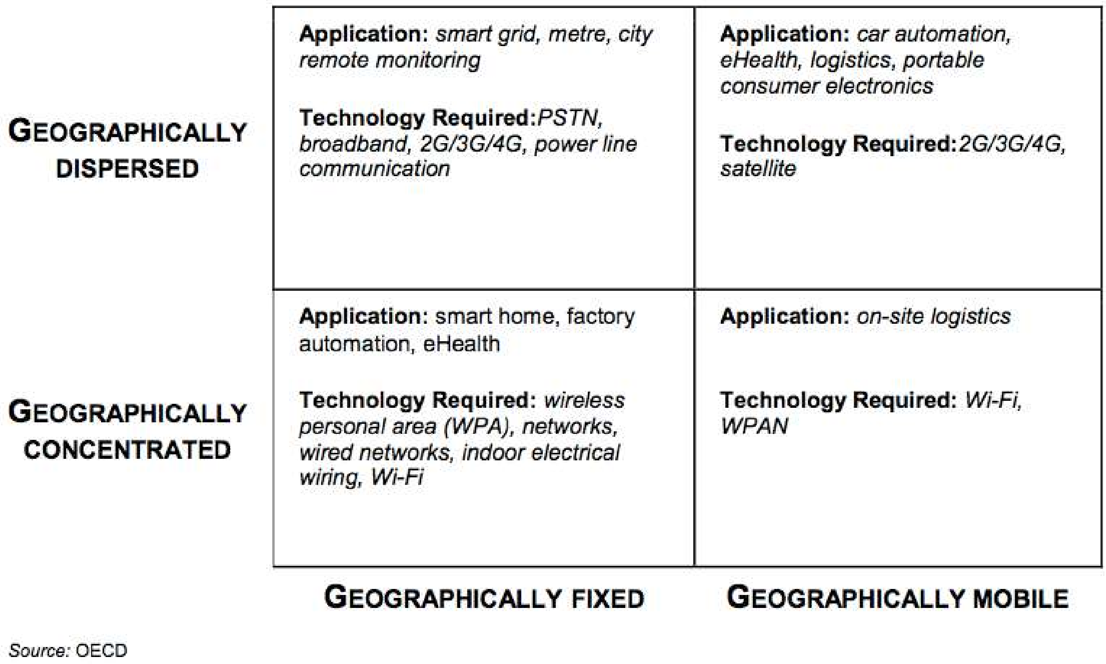

FIGURE 14 Machine-to-Machine applications and technologies, by dispersion and mobility. Reprinted from "Building Blocks for Smart Networks", by (OECD, 2013).

As it is presented in the (FIGURE 14), geographically mobile and dispersed M2M communication use cases are inherently dependent of communication service providers, such as MNOs. Wireless 2G/3G/4G cellular networks are the most efficient way of reaching the infrastructure to customers, and it ties the MNOs to the service provision domain, especially when most applications are used by web interfaces on smart phones and tablets. Geographically fixed and concentrated applications, on the other hand, are more likely on service provider's responsibility, mostly because of many overlapping communication technologies, such as Bluetooth or WiFi.

4.3 Customer value of the IoT

For an idea to be new and diffusible, the innovation should bring some new value with it. What then is the value, the motivation, of connecting physical things to the Internet?

According to Bucherer and Uckelmann (2011), the source of value in the IoT is the information both generated by and associated to smart things, while Haller et al. (2009) list real-world visibility and business process decomposition as key sources of business value of the IoT. Furthermore, value is generated by increased security and user-feedback capabilities of the IoT (Fleisch, 2010). As an innovation, the relative advantage experienced by enterprise users of the IoT can be assessed through these value drivers.

Information. Businesses are willing to invest in technology that generates information about their business environment to support the management and efficient operations. As for consumers, gaining access to rich information about physical items using the Internet increases convenience and reduces information searching costs, for example. Service providers in the Internet of Things therefore act in the information market, where the subject of transaction is information, which constitutes the value proposition of these firms' business models. (Bucherer & Uckelmann, 2011.)

Real-world visibility. With connected things, firms can both track their assets with RFID and receive richer, sensory information from their environment. More accurate and timely information serves as a basis of effective management and may even reveal previously unrecognized patterns in business events.(Haller et al., 2009.) Supply chains and logistics can be optimized, when goods are tracked with RFID, and their environment monitored with sensors (Fleisch, 2010). While data of firms' business processes are transferred in private networks, public WSNs offer open data (Bohli et al., 2009). Public services can create value by gathering traffic data from different sources in urban areas, and using it to reduce the unnecessary traffic and congestions, for example. In the future IoT, real-world visibility presumes efficient search capabilities, with which RFID- or sensor-based services can be accessed.

Business process decomposition. Using M2M communications, information can be processed on the edge devices of firms' information systems. Equipped with sensors and actuators, smart objects may make autonomous decisions based on changes in their environment. This leads to decentralized business processes, where business decisions can be made even if the connection from the edge devices to firm's central information systems is disconnected. However, moving the processing power to the edge devices involves management complexities, for the decisions of delegating parts of business processes must be made application-by-application. (Haller et al., 2009.)

Security. Embedding security intelligence into things can also generate value. To avoid thefts and unauthorized use of assets, smart things can be equipped with authenticity proofing and access controlling techniques. Digital representations of physical things can contain data, with which the authenticity of the things can be checked. (Fleisch, 2010.) At the moment, security presents, however, bigger challenges than opportunities in the IoT. Systems in the IoT can be interfered rather easily, especially when things are physical. Atzori, Iera and Morabito (2010), state, that physical smart things are more vulnerable to attacks and vandalism. Furthermore, because the communication signals between things are wireless, they are more exposed to capturing. Embedding heavy authentication and security technologies also demand high power and bandwidth, which are beyond the reach of low-cost RFID systems, for example. (Atzori et al., 2010.)

User-feedback. Augmenting the features of physical things with features of digital objects provides users with augmented feedback and rich information about the things. Smart objects provide information about themselves, and the users can obtain the information virtually with any end devices, due to digital convergence. In addition to information, different services can be accessed through relevant smart objects. (Fleisch, 2010.) The social capabilities of the Web 2.0 further increase the user-feedback generated value of the IoT. Services integrating with social networking platforms, for example, create innumerable ways of value creation to enterprises adopting the IoT paradigm.

While the IoT is a vast network with billions and billions of nodes, some network effects take place. The more nodes exist in the IoT, the more extensive services are provided to the users of the IoT. This, reciprocally, creates incentives to connect more objects into the IoT, leading to increases in the amount of WSANs and smart object networks. According to Metcalfe's law, value of a network is roughly proportional to the square of its amount of nodes, and if the amount of connected devices in the were be 50 billion and each device accounts for one unit of value, the value of the IoT would be 2500 billion billions (25 and 20 zeros). This contains a presupposition where any device in the IoT can search and query any device including itself. This network effect affects value networks, where a high degree of connectivity of one business can be seen both as a relationship-strengthening factor and a core capability.

4.4 IoT ecosystem

How is the customer value in the Internet of Things produced? Extending the Internet infrastructure to physical objects widens the value chain of traditional communications services, as new actors emerge in the beginning of the value chain, as well as actors providing enabling services along the value chain. An exemplary value chain for smart object services is presented by Sclautmann, Levy, Keeping and Pankert (2011) (FIGURE 15):

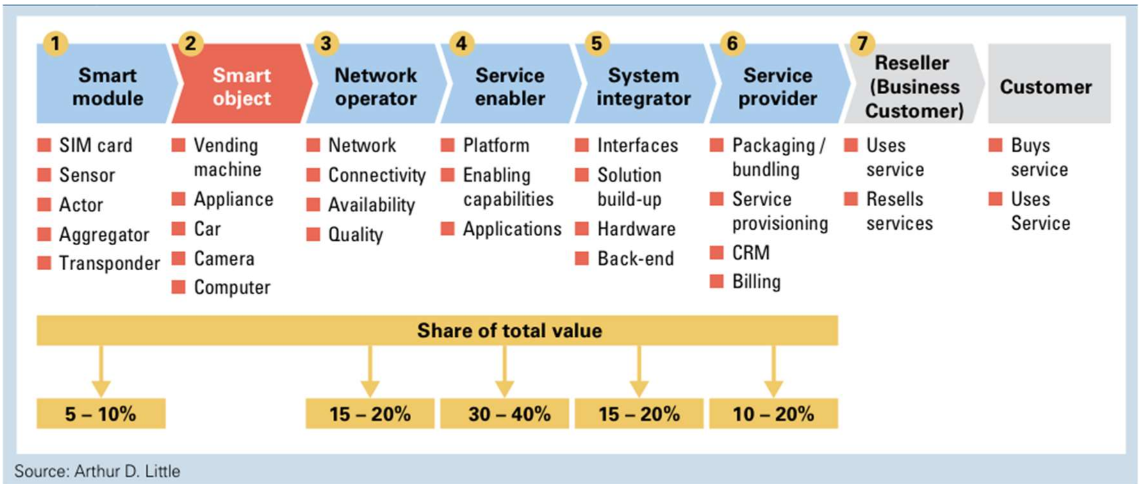

FIGURE 15 Participants in the value chain for smart solutions. Reprinted from "Wanted: Smart market-makers for the 'Internet of Things'", by (Schlautmann et al., 2011).

The value chain above shows the dispersion of value produced to firms, and more importantly, some of the key players required to produce IoT-compliant smart object services. First, the smart modules are produces, which are to be integrated into physical objects at issue. The next value-adding step is to enable the connections to the network infrastructures of network operators. Service enablers, such as platform providers, increase the value of the solution even more by offering platform capabilities for the service providers or network operators, so they could manage smart objects more efficiently. Integration of smart objects to the platform creates more value, as well as the integration of modules into the objects. The last value-adding step is the service provision, where other services, such as billing, are added to the value proposition offered to the customer. (Schlautmann et al., 2011.)

Similar value chains are common in current M2M solutions, where the customer consuming the service and receiving customer value is a vertical business. However, as it is explained in the chapter two, the value chain is not the most useful format for describing the formation of value in more complex environments, such as the global IoT. Gathering and processing the data produced by billions of network nodes in technologically divergent sensor networks, enabling the operations in the IoT and providing services using the data requires more diverse players in the emerging business ecosystem, in addition to aggregators, regulators and standardization organizations, for example.

Possible business roles in the IoT have been researched, especially in European research projects. The SENSEI-project (2011) lists additional roles adhering to the IoT vision, including WSAN operators, WSAN service providers and sensor and actuator service brokers. Furthermore, Stanoevska-Slabeva et al. (2010) present an ecosystem with roles needed for provision of Internet-mediated context information services and the related financial and information flows. Mazhelis, Luoma and Warma (2012) present a generic IoT ecosystem based on previous M2M and WSAN ecosystem research, including the aforementioned researches. Their ecosystem, which is depicted in (FIGURE 16), comprises total 29 different roles, some of which are application-specific, and are not present in use cases.

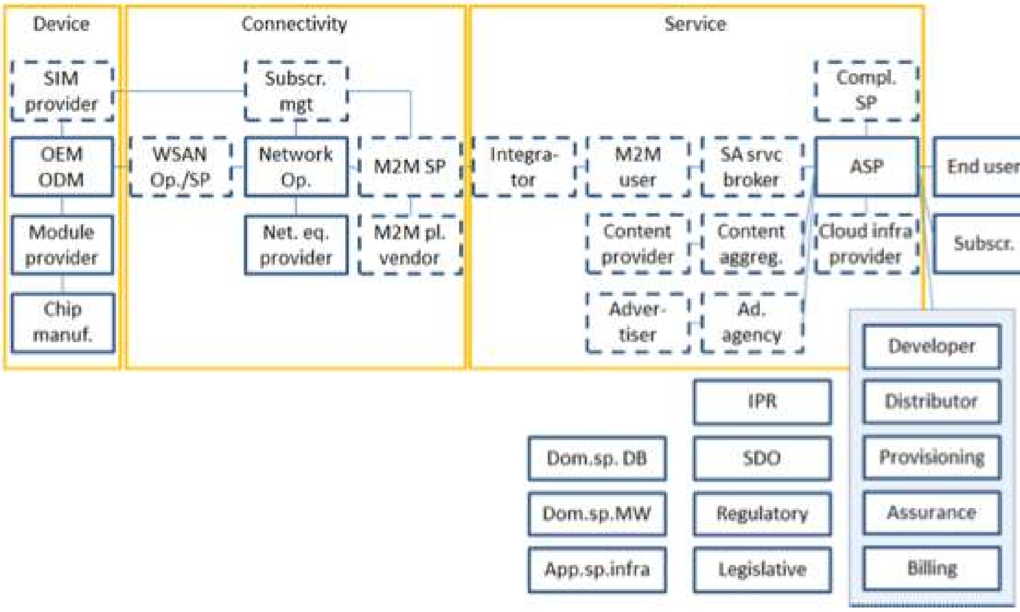

FIGURE 16 Roles in an IoT ecosystem. Reprinted from "Defining an Internet-of-Things Ecosystem", by (Mazhelis et al., 2012).

The device domain is roughly equivalent to the smart module step of the value chain in figure 15, and it includes actors from hardware industry, mostly equipment manufacturers; component manufacturers manufacture components from integrated circuits to modules, such as sensors or radios. OEMs and ODMs integrate the components into devices. In addition, SIM providers are needed to manufacture SIM-cards and embedded SIMs to enable authenticity controlling for MNOs in SIM based solutions. (Mazhelis et al., 2012.)

In WSAN applications, local operators of WSAN islands reside between the identification and network layer, which in turn is dominated by the network operator. The function of the network operator is to provide connectivity between the devices and the applications. Thus, M2M service providers are deeply dependent of network operators. Network equipment vendors, service integrators and regulators also have relationships with the network operator (Kaleelazhicathu, Gjerde, Smura, Hämmäinen & Tesch, 2004; Mazhelis et al., 2012.)

M2M platform vendors are of specific interest, especially from network operator's point of view. In some cases, platform vendors have a relative large role in the connectivity domain, but in other cases the role may be merged with the role of network operator, depending on whether the network operator operates both the connectivity and M2M service platforms, or furthermore, develops the platforms self. Operators can build their own platform capabilities in order to offer more integrated M2M solutions to service providers, but with a higher risk of reduced interoperability and technological innovation.

Acting entirely in a service domain are application service providers (ASPs), and M2M users, who provide end-services to end-users. Also integrators, cloud infrastructure providers and other service enablers participate in this domain. Content providers and content aggregators create digital content and direct it to service providers, and if business models require advertising revenues, advertisers generate revenue by adding advertisement to services. Last, value created in the ecosystem is delivered to and consumed by the end user, who is, or may not always be, also the subscriber of the service. Depending on IoT service, the end-user makes contracts directly with ASPs or network operators or with both. Last, outside of all the domains reside the actors with no direct contact to value creation, but which are critical for the ecosystem to exist. Especially standard development organizations (SDOs) are of great importance, because ecosystems are most likely based on a set of standards, determining the core business. Regulators and legislative bodies impact the business ecosystem as well. (Mazhelis et al., 2012.)

It is useful to emphasize on the differences between the M2M users and end users: The M2M users are companies wanting to create value by connecting objects to the Internet, such as utilities companies, car manufacturers, cities or hospitals, while end-user is the, consumer, driver, citizen or patient, who interacts with the smart object. Therefore, the end-user consumes and uses the M2M service and receives customer value. Currently, M2M business is to a great extent B2B, or B2B2C business, where solutions are marketed to M2M users, who then may offer M2M-enabled services to end users.

As opposed to basic M2M business, the role and variety of intermediaries is much larger in the Internet of Things. Opening technologically isolated WSAN islands and smart object networks creates a need for orchestrating the data flows in several levels. WSAN operators act as intermediaries between the device domain and network domain, and WSAN brokers and content aggregators can provide value-generating services to multiple parties in the value network. Bohli, Sorge and Westhoff (2009) state, that the IoT is equally dependent on (micro) providers of sensory information and intermediaries connecting them to relevant customers. It may also be profitable for these intermediaries to subsidize providers of information (Bohli et al., 2009). For information providers, such as WSAN operators, costs of finding a financially sufficient amount of customers may rise too high, whereas third party intermediaries can leverage on economies of scale, and connect to multiple information providers and customers.

4.5 Current stage of the Internet of Things

In order to evaluate the future and evolution of the Internet of Things, the current evolutionary stage of the paradigm must be resolved. The exact position of the IoT on the technology adoption life cycle cannot be determined effectively, because of the scale of it; the IoT has not got a market share or competitive products, but the maturity of the market can be assessed by using the TALC model. This gives an estimation of the current stage of the Internet of Things, and gives way to further analyzing the evolution of the entity.

It is clear, that the IoT is still in its early evolutionary stages. Many technological issues concerning communication standards, architectures, security, privacy and energy management need to be resolved, before the IoT can be implemented. Moreover, in order to accumulate critical mass for the market, suitable business roles and business models need to emerge. If the IoT is reflected using the technology adoption life cycle, it can currently be seen as residing in the Chasm. M2M and RFID technologies have passed the laboratory and demonstrations stage, and technologies have been communicated to early adopters. The early adopters are vertical enterprises, who invest in this technology in order to reduce costs in their respective business and gain a strategic advance against their competitors. Some adopters can be even considered as the early majority, because they adopt M2M solutions to offer new services instead of cutting costs in the long run. A barometer implemented by Vodafone and Circle Research revealed, that only 12% of respondents had an M2M strategy in action, which can be seen as an indicator of early stages of M2M diffusion (2013).

The Late Market is, however, not yet ready for widespread adoption of the IoT, mostly because the IoT does not largely exist outside vertical M2M silos. Uckelmann, Harrison and Michahelles (2011a) refer to these silos as Intranets and Extranets of Things. Qiao and Wang (2012) have observed this "quake lake problem" in the Chinese IoT market, where the lack of common networking standards, low level of collaboration in R&D and production across the value chain, and high costs of IoT applications prevent the whole industry from growing rapidly, thus remaining in the Chasm. Using the IoT definition of Uckelmann, Harrison and Michahelles (2011a), the most distinctive difference between current M2M silos/intranets of Things and the Internet of Things is that in the IoT, theoretically any non-predefined individual has access to digital representations of things. Vertical M2M silos determine the users of sensory information strictly, and end users are tied to the smart object manufacturer or the M2M user organization.

The lack of interoperability can be seen as the biggest obstacle of critical mass accumulation and ecosystem formation in the Internet of Things. Devices deployed in WSANs are often connected using proprietary, vendor-specific protocols, as opposed to IP protocol. To get sensory data from isolated WSANs, for example, requires the translation of IP to non-IP protocols using dedicated gateways. Standardization efforts to develop standards for addressing objects in constrained WSNs or smart object networks using the Internet protocol, such as by the IETF, are crucial for the diffusion process of the IoT, because they remove the lock-in effect of vendor-specific gateways and proprietary protocols. The acceptance of standards built on top of existing communication standards, such as IEEE 802.15.4, accelerates the interconnectivity between connected things and networks, and ultimately the realization of the IoT. (Ishaq et al., 2013.)

Further standardization is needed in the service layer of the Internet of Things. Open application platforms abstracting the technology behind M2M gateways and WSANs open the market for application developers, but need to be based on common standards. Therefore, the diffusion of the Internet of Things is heavily dependent on the diffusion of open, standardized middleware platforms. Vertical integration separates the Intranets of Things from the Internet of Things, and by connecting different vertical WSANs to the Internet using open, standardized middleware, the growth of the IoT ecosystem would very likely accelerate and lead to a mass market of IoT-related services and products. Also open architectures need to be determined for the IoT, of which the SENSEI architecture seems prominent and conforming to the IoT-A -reference architecture.

Increasing interoperability is the top priority of numerous IoT initiatives, such as SENSEI, IoT-A and standardization initiatives of IETF and ETSI. The development of these initiatives and emerging business around them can catalyze the diffusion for interoperable WSANs. Because of the size and heterogeneity of the future Internet of Things, no "one-size-fits-all" connection and communication standards are going to be developed. The use of open standards for internetworking and open APIs for vertical WSANs are the key to integration of M2M silos, resulting in an open, IP-based, flexible architecture for the IoT as the basis of the Internet of Things. The use of open standards and APIs reduces integration costs for M2M silos and increases the value in value networks by reducing transaction costs and opening WSANs towards 3rd party application developers.

If the emergence of a standardized architecture for the IoT follows the theory of vertical software industry evolution, the de facto standard is more likely to emerge as a product of competing ecosystems than as a product of standards developing organizations (SDOs). Ecosystems forming around M2M service early movers, such as MNOs, M2M platform vendors and some vertical actors, are most likely to produce the de facto standard for the preliminary architecture of the Internet of Things. However, the role of reference architectures, such as the IoT-A or SENSEI, still has a major influence on the emergence of the dominant architectural design. Adopting standards lowers the critical mass of adopters in innovation diffusion, and all actors in respective value networks should pursue it by collaborating with SDOs. Therefore, it is likely that vertical WSANs begin to open towards horizontal service providers as the market determines the standards.

When the term future IoT is used in this thesis, it refers to the future state of infrastructure and market, where isolated WSANs are integrated into the Internet via these standardized interfaces and middleware. The future IoT also presumes, that there are end users accessing this information in the Internet.

5 System reality

MNOs are well positioned in the upcoming market of IoT services. Mobile networks are a scarce resource, which MNOs have access to, by acquiring expensive wireless communication spectrum and building wired networks connecting separate networks together. Another incentive for MNOs to attend in the IoT market in large scale is to fill a role of the intermediary between the M2M service providers and end users. MNOs have been investing in M2M technology and compete in new markets, as revenues decline in the traditional market of voice and data (GSMA, 2013). Because of thinning margins in just transferring data in networks, the future IoT drives MNOs to find dominant roles in the ecosystem, and reassessing their competences in order to generate revenues.

5.1 Telecom industry

Telecom industry is a substantially large industry, touching nearly all other industries either directly or indirectly. GSMA (2013) reports, that in 2012, the mobile industry accounted for 1.4 % of the global GDP, and the industry keeps growing, especially in Asia and Pacific and Africa, where mobile operators' contribution to GDPs is even higher. In contrary, the European industry is decreasing (GSMA, 2013) due to regulatory factors, which have driven inter-country tariffs and prices low, as well as operator revenues (Al-Debei & Avison, 2011).

Telecommunications industry has undergone major changes since the appearance of wireless communication technologies and increasing commercialization. Telecommunications sectors in the United States, United Kingdom, Japan (Li & Whalley, 2002; Wirtz, 2001) and Europe (Kiiski & Hämmäinen, 2004; Stienstra, Baaij, Van den Bosch & Volberda, 2004) have been opened for competition in order to provide business opportunities to new entrants, such as mobile virtual network operators (MVNOs), or firms from other industries providing higher-quality services or more advanced technology. Innovations, such as the Internet and the World Wide Web, have also heavily impacted the telecommunications industry, as well as other industries. The Internet offers firms a highly standardized and widely accepted digital delivery channel, through which services and digitalized products can be transported to customers cost-efficiently (Li & Whalley, 2002). MNOs' original value proposition, voice communication, has been complemented by provision of data and content, which now form the core of MNOs' businesses. MNOs provide the connection to the Internet, and therefore act as the link between the customers and digital services. In addition to services business, MNOs also engage in product business. Communication devices, such as telephones, mobile telephones, computers and tablets are retailed in both B2C and B2B markets.

According to Finnish Communications Regulatory Authority (Viestintävirasto, 2012), about 50 per cent of the revenues from Finnish telecom industry's telecom operations comes from services offered in wireless network, and nearly as much from the fixed network, leaving a fraction for TV- and radio operations. Globally, the number of mobile cellular subscriptions has risen from 15.5 per 100 inhabitants to almost 90 subscriptions per 100 inhabitants from years 2001 to 2011, whereas fixed telephone subscriptions have stayed the same and recently decreased (ITU, 2013). It is clear, that wireless communication technologies are surpassing wired technologies in the future, and the amount of devices connected to mobile networks increases.

Already, the diffusion of smart phones, mobile PCs, tablets and other cellular web-using devices has caused substantial increases in mobile data traffic (Irmer et al., 2011). According to a research conducted by Swedish telecom service and technology provider Ericsson (2012), global wireless data traffic has increased from marginal levels to almost 700 petabytes per month in just over five years (FIGURE 17). Therefore, it is likely that the diffusion of M2M applications and the possible emergence of the IoT are going to raise the rate of growth to a complete new level. However, this is not necessarily good news for mobile network operators; although data volumes are increasing rapidly, the revenues from data transferring are falling due to lowering prices and increased competition (GSMA, 2013). Moreover, evolving communication technologies and growing mobile data traffic implicates costly investments to wireless networks, which cannot be covered with mobile data subscription revenues alone.

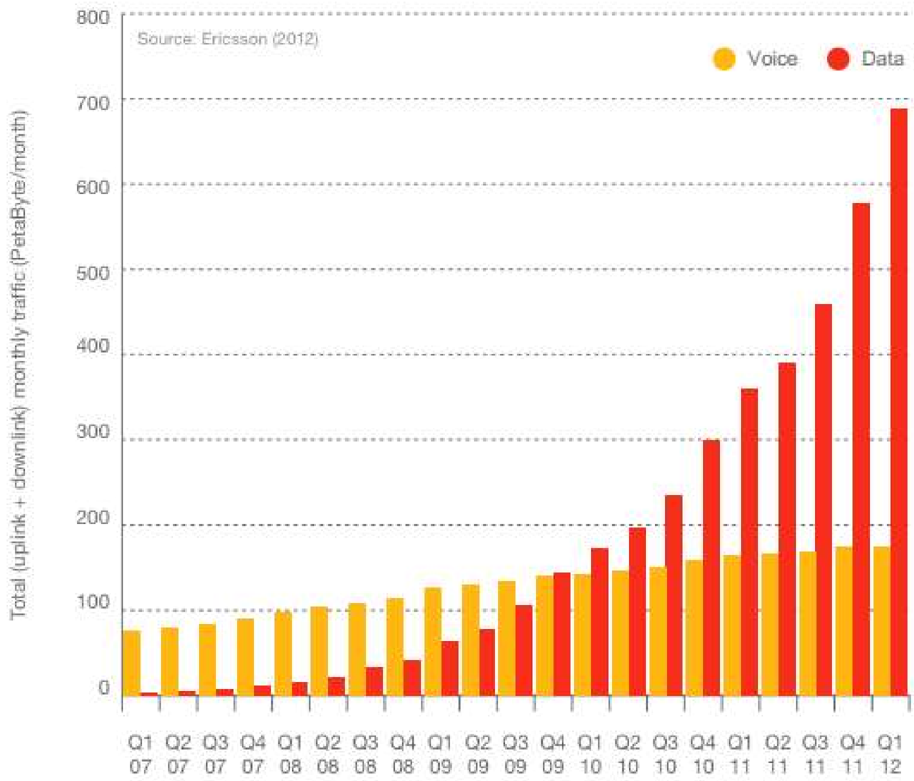

FIGURE 17 Global total traffic in mobile networks, 2007 - 2012. Reprinted from "Traffic and market report - On the pulse of the networked society" by Ericsson, 2012.

Increasing digitalization also drives digital convergence, which means that different services and products can be delivered to various kinds of end-devices utilizing the same infrastructure; phone calls can be made with laptop computers and movies can be watched with smartphones. Convergence is also experienced between fixed and mobile infrastructures. MNOs operating in both domains offer services through both infrastructures, which enable the customer to receive the same services irrespective of the connection technology (Pollet, Maas, Marien & Wambecq, 2006).

While the penetration of smart phones and tablets has created mobile Internet subscription revenues to mobile MNOs, it also creates challenges to the traditional MNO business. Due to digital convergence, voice and SMS-services are increasingly substituted by OTT-services (Over-the-Top-services) such as Voice over IP (VoIP) and Internet-based messaging, leading to declining voice and message revenues.

Emerged cross-industry competition has increased the competition within the communications market. Wirtz (2001) proposes a single macro-market, a media and communications market, as a result of the merged telecom, media and IT-/consumer electronic industries, whereas Li and Whalley (2002) refer to the datacom space, where incumbent MNOs, equipment suppliers and OTT-service providers both *compete* and *complete* each other. Furthermore, the media and communications market is only a part of a cluster of markets, when actors from WSAN-, consumer electronics, healthcare, vehicle and water- and electricity infrastructure industries join the value network. It is clear, that this technology-enabled industry transformation requires major strategy- and business model alterations from MNOs, who provide the link between different vertical services and users.

5.2 MNO business model

As a basis of an evolutionary futures research a unit of analysis representing the reality is needed. In this thesis, the unit of analysis is an archetype of a mobile MNO illustrated by a generic business model. By synthesizing information about different specific MNO companies, industry reports and academic research, main aspects of a MNO business model are identified. Operators offering mobile communication services are also referred to as MNOs (Mobile Network Operators), Other operator-like actors in the industry are Mobile Virtual Network Operators, which are operators offering telecommunication services without owning the network infrastructure, which is, in effect, retailed to MVNOs usually by MNOs (Li & Whalley, 2002), and Mobile Virtual Network Enablers (MVNEs), which are a special type of telecom companies selling network infrastructure to MVNOs without offering further communication services (Emmerson, 2010).

Fragmentation of the telecommunications market has directed the tendency towards value networks, mostly because of the diffusion of the Internet-technologies and resulting transaction costs. Firms from software, middleware, integration, network equipment and several other markets have entered the mobile market, bringing superior core capabilities with them. What has before been MNO's business, has now been dispersed the into value network. This most likely causes MNOs to reassess their core capabilities and adjust their business models.

A recognized pattern of telecom business model change is unbundling (Osterwalder & Pigneur, 2010). To lower transaction costs and leverage on the core competences, formerly vertically integrated telecom companies outsource network infrastructure deployment and management to equipment manufacturers, who leverage on economies of scale, whereas content and applications, such as entertainment or navigation, are bought from smaller specialist companies, who are more innovative and can bring products to market with greater speed. What then is left for MNOs after the unbundling? The main business for them is to offer the services and channel content to customers, and cultivate the customer relationships through effective branding and segmenting. (Osterwalder & Pigneur, 2010.)

This pattern is similar to Treacy and Wiersema's (1993) classification of value disciplines, where network infrastructure companies follow the operational excellence discipline. Their main priority is to make sure that the network is functioning reliably, the QoS is high and costs of operating the infrastructure are low. Third parties, such as application and content providers, represent the highest quality of their niche, and pursue product leadership. MNOs can aggregate content and applications from these providers and market them to customers, pursuing customer intimacy. Thus, MNOs core business has transformed into a customer relationship business, where the main asset is the established customer base, and more importantly, the data about customers, were they B2C or B2B customers. The unbundling pattern is illustrated below in (FIGURE 18).

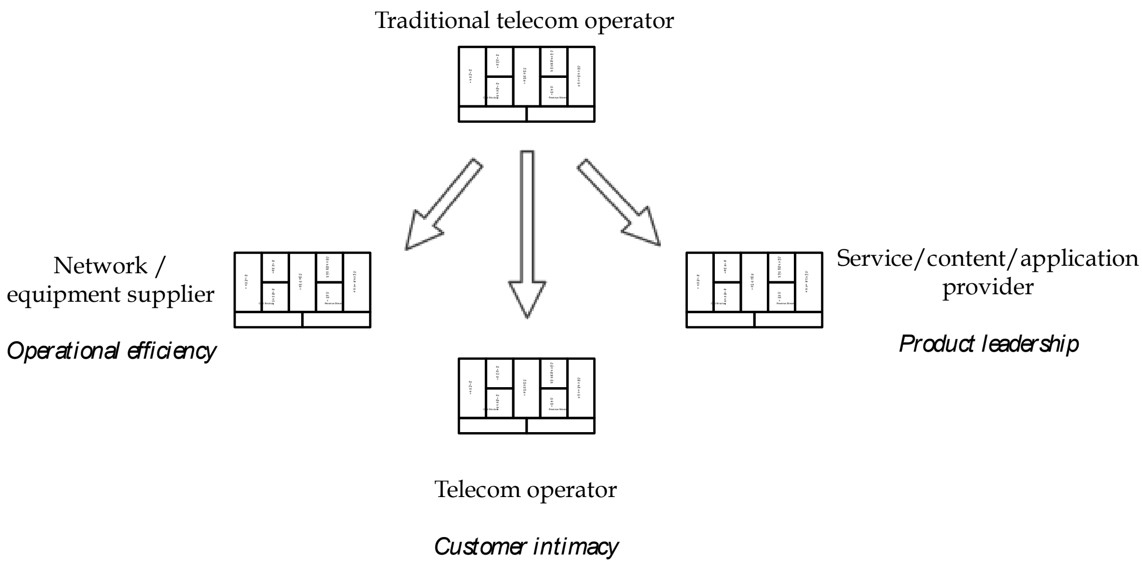

FIGURE 18 Telecom unbundling. Adapted from "Business Model Generation" by A. Osterwalder and Y. Pigneur, 2010.

In Osterwalder and Pigneur's (2010) example, a post-unbundling, generic MNO business model canvas looks like the following (FIGURE 19):

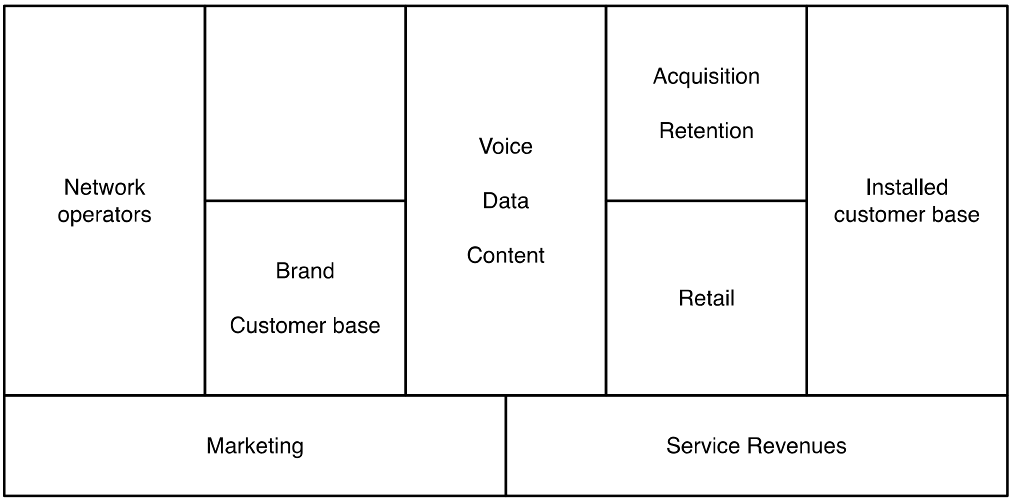

FIGURE 19 Unbundled Telco. Adapted from "Business Model Generation" by A. Osterwalder and Y. Pigneur, 2010.

The business model canvas above represents a customer value –driven business, where the brand and customer base resources are used to strengthen the value proposition. The operator is responsible for most of the marketing activities of the whole communications value chain, acting the closest to end users. If network infrastructure is outsourced as a whole, this business model canvas relates closely to MVNO business models, where infrastructure capacity is bought from network operator. The relationship between a network operator and an MVNO could also be the same than of an MNO and an MVNO, where the MVNO is subsidized or owned by the MNO.

The business model generalization above is suited for B2C and B2B markets where communication occurs mostly between people. When moving from converged media and communications industry towards M2M industry, value networks get more complicated as actors from other industries are incrementally involved along with the evolution of the IoT. Also, MNOs are not as detached from the network infrastructure as it is presented in the unbundling scenario, but instead treat the network infrastructure as a resource, of which production is outsourced to network companies, along with network performance activities.

Value proposition

In order to gain comprehension about current M2M value propositions of MNOs, ten operators were reviewed using available information from corporate websites. The operators reviewed were:

- AT&T
- Verizon
- Sprint
- Telefonica

- Orange
- Vodafone
- Deutsche Telekom
- KPN
- TeliaSonera
- Rogers

In the context of M2M communications, **device connectivity** is the core value offered to customers. All reviewed operators build their value propositions around the connectivity between customer's devices and information systems via WWANs. Connectivity is instrumental to customer enterprises' value drivers, which are presented in Chapter 4.3, and therefore, is the value MNOs deliver to vertical customers. For MNOs, the network infrastructure is the key resource, and providing the wireless connectivity to it cannot be done by other actors, apart from MVNOs. The value from connectivity builds on operator brand, network coverage and quality of the network, which all are communicated to convince vertical customers. While the core utility is connectivity, network QoS and security are also expected from MNOs' connectivity value propositions. In the case of millions of directly connected smart objects and gateways, network monitoring and traffic controlling mechanisms are needed to maintain service availability, usability, transmission speed and other QoS parameters.

The second key element of M2M value propositions is a cloud-based **M2M platform**. Platforms bring value to customers by offering them tools to self-manage and administrate their connected devices and integrate data from connected devices to business processes with applications. M2M platforms change the basic bit-pipe connectivity value proposition to a *managed connectivity* value proposition, where the basic connectivity is supplemented with expected functions, such as reporting tools, object localization, device provisioning and billing.

MNOs' platform offerings consist mainly of two parts: Service Delivery Platforms (SDPs) and Application Delivery Platforms (ADPs). SDPs, such as Ericsson's EDCP (Blockstrand, Holm, Kling, Skog & Wallin, 2011) and the Jasper Wireless Connected Device Platform (Cisco Systems, 2017.), enable the connectivity between M2M modules, MNO's mobile network and the M2M user's information systems. They also offer service enablement functions, such as rate/policy control and subscription management. SDPs are positioned more clearly in the network domain, and they form the basis of MNOs' M2M business. ADPs, such as PTC Axeda (ptc.com, 2017) and Cumulocity's (cumulocity.com, 2017), enable the development and operation of M2M applications by abstracting smart objects into "technology-agnostic" functionalities to be managed via the SDP. (Weldon, 2012.) Together these different platform functionalities can be used to provide vertical M2M users an M2M whole product, which connects the M2M devices to M2M users' business processes and creates them new value creation opportunities.

These connectivity solutions also combine professional services from design and consulting to M2M system construction, deployment and customer service. When value-adding functionalities and connectivity are bundled as a whole product, operators stand out as only actors who can provide end-to-end solutions in the IoT market. Together the elements of the value proposition create business value for vertical customers in form of increased information and real-world visibility.

Key resources

The communications network **infrastructure** is the most important tangible asset of an operator (Hultell, Johansson & Markendahl, 2004). While the unbundling pattern leaves the network building and maintenance to network companies, the core networks are still owned by operators. Taking the mobility of M2M communications into account, the most important part of the network infrastructure is the cellular network. In addition to investing in the network, operators must also buy the wireless spectrum reserved to commercial communication. In M2M, network coverage and quality as network attributes are emphasized more in than in conventional communications. Lower capability 2G-networks are considered as practically ubiquitous, with the widest coverage of mobile networks, while 3G networks cover more densely inhabited areas. 4G LTE networks have the least coverage, but offer more capacity in data transferring. The quality of M2M-services is therefore critically dependent on the network. Network infrastructure is also a key resource for MVNOs, even if they have limited control over the infrastructure.

In addition to communications network, **customer base** is an important intangible key resource connecting MNOs to the M2M market. They can leverage on different vertical customers, some of which have specific requirements for IoT-applications. MNOs also possess information about end-users and their communication statistics (Stanoevska-Slabeva et al., 2010), which proves valuable especially in B2C markets.

A differentiating key resource in operator M2M business is the M2M **platform**, whether it is developed in-house, or purchased from an external M2M platform vendor. Device connectivity platforms may offer MNOs the way to create more value to enterprise customers, while simultaneously generating more revenue per connected device to MNOs. Activities such as subscription management, billing, SIM/device connection provision and monitoring, can be performed using M2M platforms.

For MNOs, the key aspect of platforms is automation. As platforms automate the key processes of M2M system management, such as device provision, operators experience a lower operator cost, which is critical in M2M business, where the average revenue per connected device is a fragment compared to a single smart phone connection (Cisco Systems, 2017). Furthermore, M2M platforms horizontalize the industry by creating a mutual integration point for companies to integrate to within a value network (European Communications, 2012).

Key activities

MNOs perform a large array of activities, which are determined by business processes of the operator. The Enhanced Telecom Operation Map (eTOM) provides a process framework, where processes are grouped into three groupings: strategy, infrastructure and product processes, operational processes and enterprise management processes. The first process grouping includes processes, which require higher-level decision-making. Developing strategies for the company, as well as planning and managing the life cycles of both the enterprise, and enterprise's infrastructure and products belong to the planning level of FIGURE 4. What are of interest, are the activities relevant to the operator business model, which reside in the operational processes grouping: customer relationship management, service management and operations, resource management and operations, and supplier/partner relationship management. (Kelly, 2003.)

As the telecom unbundling pattern illustrates, **customer relationship management (CRM)** is the key activity in MNO's business. Resource management and operations consists mostly of **M2M platform management** and **operations**, because majority of network management can be outsourced to infrastructure companies. **Service management and operations** activities, such as planning, configuration, problem resolution, and service quality management, form the core of the connectivity service value proposition, and are thus naturally key activities of an MNO (Camponovo & Pigneur, 2003.) Majority of reviewed MNOs emphasize the importance of expert partner networks, with which most vertical industries and customers can be serviced. MNOs also actively seek new partnerships and offer partnering programs for M2M service providers, M2M technology providers, system integrators and other M2M actors seeking distribution channels, customers or other partners. Thus, **supplier/partner relationship management** in M2M communications business is a key activity of MNOs.

The enterprise management section of the eTOM framework includes **marketing** elements (Kelly, 2003), which can be included in the business model of the MNO in M2M markets. Because of the exceptionally large partnering landscape of and requirement for ecosystems in M2M, advertising, market research and relations management activities are of great importance. Marketing differentiation channel coordination may be required from MNOs in order them to create ecosystems around them.

Key partners

In the European Communications quarterly report (European Communications, 2012) it is explained, that contracting right partnerships is the most difficult activity for MNOs entering the M2M market. After all, partners and forms of relationships MNOs are used to associate with, are distinct from ones in traditional voice/data business.

Osterwalder and Pigneur (2010) divide business partnerships into four types: strategic alliances between non-competitors, strategic partnerships between competitors, joint ventures and buyer-seller relationships. Buyer-seller partnerships are the most important of relationships in value networks, because they determine the structure of the ecosystem, and the flow of resources towards the value proposition. As telecom business get disintegrated, network infrastructure provision and management is separated from the operator business. Therefore, **network infrastructure companies** are the most important type of partners required to produce the value proposition. Second, **M2M technology providers**, such as SIM providers, module providers, OEMs, network equipment providers and chip manufacturers are key partners in the M2M products market. Also **software providers**, such as M2M application service providers, and **system integrators** are included in the key buyer-seller partnerships. (Mazhelis et al., 2012.)

The scale of the M2M market requires MNOs engaging to alliances with both competitors and non-competitors. MNOs seek economies of scale and internationalization opportunities by forming strategic partnerships with **other operators**. Also **virtual operators or MVNOs** can be engaged to operate specialized M2M environments or deploy smaller scale M2M systems (Lucero, 2010). Strategic alliances may also include players from other parts of the M2M value chain, of which the most important are **platform providers**. For example, in 2012, mobile network operators KPN, NTT DoCoMo, Rogers, SingTel, Telefonica, Telstra and Vimpelcom formed an alliance around the M2M platform provided by Jasper (Morrish, 2012). The alliance in this case consists of both competitors and non-competitors.

To get to vertical markets, operators may have to acquire vertical partners, such as vehicular telematics companies, healthcare technology providers, security system providers and consumer electronics companies. **Vertical service providers** offer services using their market positions in their own vertical markets and partnering with them, operators can offer services via those service providers customers are already accustomed with.

Although MNOs can provide M2M services themselves, reviewed MNOs also offer M2M services through specialized **M2M service providers**, to whom MNOs offer their network connectivity solutions instead of going straight to vertical customers. In this case, service providers provide M2M solutions to vertical markets using MNO's sales channels and customer relationships.

Customer relationships

Customer relationships with M2M service providers are **automated** to a degree, when an M2M platform is used. Vertical M2M customers can manage their own connected devices, or 3rd party M2M service providers can do it. On the other hand, creating end-to-end connectivity solutions with vertical M2M users requires highly **customized** customer service, especially in the beginning of the relationship. If there are problems with the platform, for example, MNOs need to maintain professional support services. Also the required partnerships, devices and service levels can vary between vertical application domains and customers. The types of customer relationships also vary between different verticals.

M2M platforms enable the **co-creation** of M2M services, which characterizes the relationship between MNOs and vertical M2M users. The services could not be provided without one of another, which creates dependence between the two. Therefore, the term partnership is more accurate than provider-customer relationship.

Last, vertical M2M solutions include a **lock-in** effect in customer relationships. M2M users experience lock-in due to M2M platforms, but mostly due to operator's network coverage and roaming agreements. M2M connectivity services require network connectivity and SIMs, which are tied to MNO's network and roaming partners' networks. Changing the operator could cause issues, where devices cannot be connected or roaming is much more expensive in some geographical markets.

Customer segments

The M2M market differs greatly from traditional, voice- and data-based telecommunications markets; M2M connectivity solutions are exclusively marketed to businesses (**B2B**), or businesses reselling them forward to other businesses (**B2B2B**). B2B customers can use M2M communications on operative level, streamlining and optimizing business processes, and strategic level, using data from devices and sensors as a decision-making tool. B2B2B customers are mostly M2M service providers, to whom network connectivity is sold, possibly on a wholesale basis.

B2B2C marketing is seen in some M2M implementations, such as smart energy metering or remote vehicle diagnostics, where M2M service is primarily marketed to energy providers and car manufacturers, but the end-users receive the most value from connectivity. In B2B2C markets, the M2M is not used to pursue just operational efficiency gains, but to enable new services, which generate value to end customers.

Channels

Marketing of M2M solutions is done mainly by using **professional sales**. The degree of customization and provider-customer coupling is so high, that the buying process is similar to large information systems process. However, cloud-based **M2M platforms** provide a channel between the operator and the M2M user. The cloud-based M2M platform can be used as a channel, via which value proposition is delivered efficiently, scalable and customized to customers' requirements. This obliterates the need of constant human service channel. If M2M platforms include application development capabilities, M2M users can create their own M2M applications using the platform, without conventional buying process.

Especially Deutsche Telekom has adopted a very clear **e-commerce** approach to M2M marketing. Customers of the operator can purchase modules, components, applications and entire end-to-end services from an online store. Furthermore, Deutsche Telekom uses a web-portal for partner networking and partner-generated M2M solutions marketing. (Deutsche Telekom, 2016.)

Revenue streams

As it is presented in the post-unbundling pattern of the MNO business model by Osterwalder and Pigneur (2010), the main source of MNO's revenue comes from services. Mobile subscribers pay for communication and data services, which use MNOs' networks. As the M2M is all about data, **data services** form the revenue stream of MNOs. As opposed to telephones and smartphones market, the M2M market does not support high ARPU (Average revenue per user), because the amount of data communicated by the devices is minimal. Traffic-based pricing can be used to generate revenue streams to operators in M2M. M2M users can either pay for the exact amount of data transported in their applications, or the pricing can be based on traffic tiers.

However, traffic-based pricing in case of low-ARPU, low-traffic generating devices does not yield large margins, even though one subscriber might have thousands of devices. Cost of a single maintenance visit to fix an M2M gateway might erase the whole revenue generated by the customer. Low ARPU can be supplemented with service revenues from **professional services,** which are meant to support the M2M adoption process and the life cycle of the M2M solution. These may include consultancy, project management and service desk activities.

Cost structures

MNOs experience high fixed costs, when compared to many other types of businesses. The cost of deploying the core and access **network infrastructures** is substantial, in addition to the cost of wireless spectrum required for mobile networks. In M2M business, acquisition of the **platform** is required, and it may cause high fixed costs to the operators, but is likely to lower operating costs in the future because of automation of operations. Other costs arise from marketing, especially customer acquisition and retention, and administration.

Variable costs for operators are proportional to the amount of M2M subscribers and connected M2M devices. While mobile phones and tablets have the life cycle of a couple of years, M2M modules may have to function for decades. If the number of modules of an operator is measured in millions or billions, the **total cost of ownership (TCO**) of these modules must be taken into account. The TCO includes the cost of the module itself, data traffic costs, design and provision costs and additional costs, such as replacement or repair costs, if the module malfunctions. According to Analysys Mason report (2010), widely used 2G modules have a higher TCO than 3G modules because of their maturity. While 3G modules are more expensive, the acquisition costs are offset by lower data traffic costs. (Sanders et al., 2010.)

5.3 System reality

As the business model elements discussed above describe, MNOs' M2M business requires a large ecosystem with different types of partners and distinct customers. MNO business model is part of a value-creating network, where each participant's core capabilities, relationships and produced customer value interact, as in Kothandaraman and Wilson's (2001) model depicted in figure 3. The role of an MNO is to transform internal resources, such as the network infrastructure, and external resources elicited from relationships and active partnering, to customer value emerging from connected objects.

On the basis of knowledge about MNO business and machine-to-machine communications, it is now possible to present a view to the system reality, which serves as a basis of this futures analysis.

> An MNO in M2M markets is a service provider, providing connectivity services to B2B, B2B2C and B2B2B customers. MNO provides the connectivity between M2M users' devices, including communication devices and smart objects, and customers' business processes by using wired and wireless network infrastructures, which it either owns or has access to via another MNO. MNO provides also services via the Internet using an M2M platform, which also enables value-adding services. MNO participates in service management and operations, platform/resource management and operations, customer/contract management and supplier/partner management activities, in addition to marketing. MNOs operate in value networks, where they allocate owned or external resources and transform them to value with other service providers and technology providers by way of value co-creation.

Furthermore, on the basis of the system reality, a general, M2M associated, MNO business model can be constructed. The model defines the actions and elements, which are necessary for the business model adhering to the system reality. The generalized M2M operator business model is illustrated in (FIGURE 20):

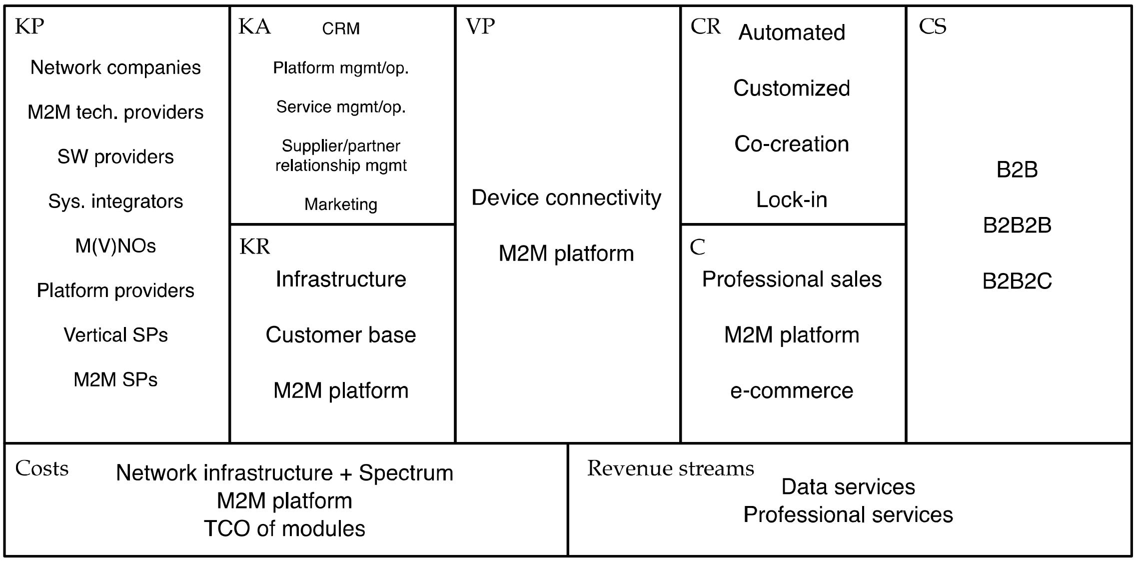

FIGURE 20 System reality of a generic M2M operator

It is noted, that in M2M, the amount and diversity of mobile MNO's partnerships increase. This is a result of a complex ecosystem, which includes cross-industrial co-operation and actors from other multiple vertical industries.

Above all, MNO business model is deeply dependent of M2M platforms. M2M platforms transform operators' business models by creating a new channel between operators and their customers. Acquiring the platform presents costs but eventually creates revenues in the long term.

To assess the comprehensiveness of the system reality, Checkland's (1981) CATWOE analysis can be used. CATWOE consists of six criteria, which all should be included in a description of a system reality: *Customers, Actors, Transformation, Weltanschauung (Worldview), Owner and Environmental constraints.* (Checkland, 1981.) The customers benefiting from the system in this case are vertical service providers, and the end-users of M2M applications. Beneficiaries of the system also include the operators themselves, because the objective is to capture part of the produced value into the business. All the employees of the MNO are actors contributing to performing the business model's activities.

As the core transformation, an operator transforms resources emerging from infrastructure capabilities and partner coordination to value from connecting physical things to customers' business processes using the M2M platform and offering related services on the platform. The Internet of Things constitutes a worldview, where this kind of system is both meaningful and required. The existence of M2M business within an operator can be determined by stockholders or the mother-corporation of the operator. The firm itself could also cease all M2M business, if the whole paradigm proves to be inapplicable or too complex to govern. Thus, the owners in this system's case are stockholders and the system itself.

Identification of the environmental constraints determining this system is critical. The constraint with the most impact is the Internet infrastructure and Internet protocols, which are taken as given by operators. A second environmental constraint is the critical mass of M2M adopters. Last, other actors of M2M value networks can be seen as environmental constraints, because without them the M2M value proposition could not be produced.

6 Future analysis

In this chapter, the perspective is shifted from "factum" to "futurum". The MNO business model elaborated in the previous chapter represents the present, whereas in this chapter the possible futures of that system are discovered and assessed in the context of the future Internet of Things. First, the core vision of the system is presented, as it describes the system according to chosen, validated factors, which are grounded on both knowledge about the present and estimations of the future Internet of Things. When the core vision is constructed, the functions of the core vision -adhering system are modeled as future business models. Last, the present and the modeled future are compared to find main differences and targets of development.

6.1 Estimations of the future IoT

Core vision describes a possible state of the future system from a single, justifiable point of view. Because the future Internet of Things is viewed from an evolutionary perspective, the core vision is presented as a temporal continuum, evolving with the technological evolution of the Internet of Things. When the future analysis is applied to business modeling, environmental forces from Osterwalder and Pigneur's (2010) framework of business model's environmental analysis can be used as building blocks, which help in estimating the future and constructing the core vision. The forces are: **key trends, industry forces, macro-economic forces and market forces.**

6.1.1 Key Trends

The most significant trends driving the diffusion of the IoT are technological. A key trend is the lowering costs of embedded processing power and wireless communication, such as RFID tags and M2M modules (Hatton, 2013). As more things can be embedded with communication interfaces, the number of nodes in the Internet of Things increases. The nodes will be dispersed into both open and closed WSANs and smart object networks, which are also likely to become more numerous when more and more things become connected in different application domains. As a result, increasing amounts of data are stored and communicated in both local and wide-area networks. The lowering costs also leads to companies increasingly adopting M2M technologies, as it is presented in a Vodafone report (2013). This supports the estimation of growth of the IoT and its applications, although it more accurately describes the growth in the amount of Intranets of Things.

The increasing amount of IoT nodes and networks has strong effects on the structure of M2M value networks. As companies in different industries adopt

M2M technologies, the variety of services offered to end users increases as well. At some point, transaction costs of accessing information from a vast number of WSAN service providers climb too high, and the need for aggregating intermediaries arises. When a user buys services from a hundred different WSAN service providers from different verticals, a role of an intermediary is necessary, if it reduces transaction costs. Additionally, different vertical WSAN service providers have their own requirements and technologies, and in some cases, end users would be faced with vast array of different technologies, pricing schemes, service level agreements and many other details, leading to increasing transaction costs per service contract.

Bohli, Sorge and Westhoff (2009) propose that intermediaries specialize in aggregating functions, reducing transaction costs of consuming WSAN services, thus keeping the prices of these services lower. MNOs' established capabilities in subscription management and billing enables them to operate as intermediaries between users of IoT services and service providers (Bohli et al., 2009). While an MNO can charge users with simple subscriptions or prepayments, it can use more complex revenue-sharing mechanisms among service providers and other value network participants.

Stanoevska-Slabeva, Wozniak, Hoffend, Mannweiler and Schotten (2010) also propose an intermediary role between sensor information providers and service providers, where the role of an intermediary is to aggregate comprehensive sensor information from many sources and sell it to service providers, who in turn offer sensor-based services to end users. MNOs' are evaluated to be able to perform in this role, because they have reusable mechanisms for capturing context information through end users' mobile devices and the network infrastructure. Although exercising WSAN information brokerage at large scale is limited due to factors of current MNO business models, MNOs can be seen as potential candidates for IoT intermediaries. (Stanoevska-Slabeva et al., 2010.)

The future IoT depends greatly of interoperable middleware. MNO's role as an intermediary gains more weight as the diffusion of these middleware technologies accelerates. Information standardization and interoperability enable the communication of machine-generated information to non-predefined participants, which is part of the IoT vision (Uckelmann et al., 2011a). It can be estimated, that similar to the effect of interoperability in the World Wide Web, the interoperability between different WSANs creates large amounts of applications and services. Thus, sensor information aggregation and brokering is required more as the interoperability between M2M islands increases. Furthermore, actors pursuing an intermediary role in the IoT could also see advantages in acting as change agents in the diffusion of interoperable middleware platforms, APIs and protocols, and collaborate with standards development organizations.

Intermediaries will emerge to decrease the complexity between buyers and sellers of machine-generated information, resulting in more efficient data communication and higher-quality services. On the other hand, introducing more business roles into IoT ecosystems increases the systemic complexity. It can be estimated, that the amount of intermediaries will be larger in the future IoT, than it is at present vertically oriented M2M applications, and the IoT is also systematically more complex, than all these vertical M2M systems brought together. Because of the tendency of increasing complexity in societal systems, complexity in technology, governance and relationships between actors increase as the IoT evolves. Therefore, intermediaries in the IoT decrease relational complexity, but increase systemic complexity.

There are societal trends affecting impacting the emergence of the IoT and the role of MNOs in it as well. People are more connected than ever, because of the diffusion of the Internet, social media and access technology. End users of the IoT expect ubiquitous wireless coverage and easy-to-use applications, which enables the IoT to integrate into daily lifestyle. Success of mobile platforms suggests that end users preferably use IoT services with mobile devices, and consume data offered by MNOs. Also services based on both things-generated data and contextual data of the end users, such as location data, are likely to be demanded because of the mobile nature of the IoT.

Adoption of mandatory smart energy meters and emergency sensor telematics applications (Morrish, 2012; Vodafone et al., 2013) are good examples of regulatory trends supporting the realization of the IoT. The reason governments wish to increase the use of M2M technologies is essentially economical. Efficient and optimal use of infrastructure is seen as beneficial, and the use of smart technologies accumulates countries' information streams, and respectively, quality of life. Smart City programs are initiatives, where IoT applications are used in wide scale to enhance the quality of citizens' lives. Because of increasing urbanization, more efficient planning and information stream optimization is required from the governmental sector and contractors in urban areas.

Last, there are socioeconomic trends, which create demand of sensor-based services and interoperability. The most significant socio-economic trend is the aging of population in many countries, combined with long-term conditions, such as diabetes. Telehealth applications can be used to provide some care to patients at their homes (Intellect, 2011). Especially in countries with high aged dependency ratio, M2M healthcare solutions are most likely demanded more. Again, this creates pressure towards MNOs and the network infrastructure. In healthcare applications, the QoS is the key performance indicator, because applications need to function reliably and sensors must communicate data to customer's business processes accurately and timely. MNOs can allocate network traffic and provide QoS to different verticals or applications case-by-case. This creates also service differentiation and segmentation opportunities for MNOs.

6.1.2 Industry forces

MNOs are currently well placed in the M2M industry due to their relationship to network infrastructure, and thus principally compete against each other's market shares. Building new, proprietary network infrastructure for the IoT is too large an investment for even the largest companies to undertake, which yields competitive advantage to the MNOs in the IoT market, who can participate at large scale without significant infrastructure investments (Camponovo & Pigneur, 2003; Hultell et al., 2004). As in the current Internet, the data in the IoT is transferred using MNO's networks, which are capable of a variety of wireless communication protocols. Any M2M service using the Internet is eventually delivered through the operator's network elements, and in most cases the MNO is the final link in the delivery chain before the end user (Li & Whalley, 2002).

Additionally, MNOs may occupy another contact points towards end-users, such as M2M devices marketing, and service and application hosting and provision (Gonçalves & Dobbelaere, 2010). In the former role, the MNO can reuse elements of retail consumer handsets business model, and market the M2M devices in place of device manufacturers, similarly to telephones marketing. However, the increasing heterogeneity of smart objects in the IoT implicates, that MNOs are most likely not able to offer the edge device selection required by end-users. As noted by Schlautmann et al. (2011), MNOs also lack the industry insights of pure hardware marketing, and should instead focus on services marketing. However, retailing middleware devices, such as smart gateways with service capabilities could be done by MNOs, especially in the first stages of diffusion to early majorities, to provide a whole product including software platform and compliant middleware gateways, both based on a same set of interoperable, open standards.

When operators engage in intermediary roles in the future IoT, they compete with actors other than service providers. Schlautmann et al. (2011), assess MNO's role as an M2M service enabler. Established network QoS mechanisms and platform capabilities in the business model can help position MNOs among service enablers. Furthermore, offering platform capabilities in the connectivity and service levels, MNOs can leverage the network infrastructure, and gain revenues auxiliary to plain data transferring. (Schlautmann et al., 2011.)

The platform business is the route MNOs are taking in order to produce M2M solutions to customers cost-efficiently and with relatively high speed-to-market. In the future IoT, horizontal connectivity platforms enabling heterogeneous things to connect to the IoT, and service platforms enabling M2M service capabilities, have even more competitive weight than now, because the heterogeneity of connected devices will be larger and the minority of connected things implements service capabilities independently.

There are two choices for MNOs to make: either cooperate with platform providers and buy a platform solution, or compete with them by creating their own platform internally. The first option is easier to implement and it may bring insights from the platform provider's business with other industries, which MNO may not have access to. This connects operator's and platform provider's core capabilities, resulting in a tight relationship in the value network. Platforms are also offered as cloud-services, which reduces the costs and risks related to engaging in an unfamiliar business (Morrish, 2012). The former option leaves the operator with much more control of the platform and the APIs it is implementing, as well as the option to license the platform to other MNOs, leading to a more considerable transformation in MNO's business.

Supported by the theory of evolution of vertical software companies, it is probable, that in-house platform development is unlikely to occur in later phases of innovation diffusion, and the diffusion of M2M technologies has already elicited a number of commercial platforms for MNOs to partner with (see for example Kim, Lee, Kim & Yun, 2013). Thus, it can be estimated, that MNOs gain access to platform capabilities through use of cooperation with external platform providers. This may result in faster time-to-market of IoT solutions, if the platform provider has experience in operating in vertical industries unfamiliar to the MNO. Also, adopting M2M platform capabilities supports the vision of MNOs participating as intermediaries in the IoT and providing the network connectivity and a service enablement platform towards vertical service providers.

For MNOs, contracting alliances between each other can be seen as an activity affecting the industry, and it is likely to continue during the further diffusion of the Internet of Things. Because single MNOs are often tied to their operating countries, alliances widen the operating area significantly. Joint operations and strategies make it possible to extend operator business to multiple countries, and thus broaden the market of potential customers. If sensor information becomes more easily available, it is probable, that MNOs seek to further increase their geographical scope via alliances with operators and vertical service providers. Value networks, such as global M2M Association (Global M2M Association, 2012), have formed to coordinate actions and increase the synergies between different MNOs and M2M actors. The vision of the Internet of Things is based on global standards and global interoperability, and operator alliances aiming to quasi-global wireless connectivity solutions can be seen as a supporting factor for achieving geographical interoperability.

As it is presented in the system reality, MNOs are central to value networks, where they connect to a large number of value-creating business partners. In addition to platform providers and other MNOs, the key partnerships in the IoT for MNOs are with actors on lower levels of the IoT, id est. WSAN operators and IoT equipment vendors, module providers, and OEMs, such as gateway vendors. By opening APIs towards WSAN operators and gateway providers, integrating constrained and heterogeneous WSANs is made more desirable for vertical WSAN operators, while simultaneously speeding up the diffusion of the IoT by faster integration of WSANs.

In a report by Machina Research (Hatton, 2013), it is stated, that M2M module vendors may also find it necessary to enter the service enablement and platform business, as the prices of modules fall. With device management platforms, module providers compete with their main customers, MNOs, but with less infrastructure capabilities. This may create competition pressure in smaller application areas, but in the heterogeneous IoT markets, where interoperability is of greater importance, module providers' device management platforms may in fact decrease the interoperability in the ecosystem. This is emphasized especially in cross-vertical applications. Therefore, MNOs are in a better position to offer enabling services to customers in the future IoT, than actors in the device and gateway domain do.

Main point of rivalry in the market of sensor-based services is between MNOs and service providers. Schlautmann et al. (2011) argue that MNOs may have better capabilities to provide connected services than smart object manufacturers, such as car manufacturers. However, some smart object manufacturers may turn to dedicated service providers, or rely on their own service provider subsidiaries. New entrants to sensor-based services provision are very likely to emerge, as markets evolve and sensor-based information is accessible through standardized, open middleware. Furthermore, the diffusion of interoperable platforms may lead to vertical disintegration and emergence of new companies in the IoT industry by standardizing information flows between actors in the value chain (Jacobides, 2005). For MNOs, enabling the IoT service capabilities to 3rd party ASPs provides further intermediary opportunities.

It can be estimated, that specialized service providers are going to proliferate in the future IoT, and MNOs are going to compete with them in sensor-based services provision. However, as stated earlier, MNOs' service brokering capabilities in the future IoT offer them an opportunity to focus on offering services to service providers instead of IoT users. Thus, the relationship between IoT service providers and MNOs can be characterized as co-opetition, a combination of competition and cooperation.

6.1.3 Macro-economic forces

According to GSMA report (2013), mobile network operators' revenues contributed 1.4% of global GDP, whereas the whole mobile ecosystem contributed 2.2% of global GDP. From a macro-economic perspective, there is a demand for the Internet of Things, because industry's contribution to GDP is likely to become higher. After all, the purpose of the IoT is to increase efficiency and automation of business processes, resulting in cost-efficiencies. Moreover, the IoT market has economy-boosting potential; it creates new companies (technology companies, service providers and intermediaries, among others), and increases the competition between firms (both new entrants and incumbents). Increased competition affects both prices and demand for IoT services. Furthermore, IoT-related infrastructure investments, increases in employment, and new products and services, all contribute to global GDP.

The role of Internet infrastructure is a profound macro-economic factor impacting the emergence of the Internet of Things. MNOs have adjusted to the fact, that the global digital infrastructure is bound to evolve continuously; first, from wired telephone lines to wireless networks, from analog to digital signals in 3G, 4G LTE and further, not to mention the backbone networks infrastructure of optical fibers underground. The infrastructure needs to evolve along the technological paradigm, in order to enable efficient communications in the IoT. In a report provided by ABI Research (Lucero, 2010), it is estimated that in the future, MNOs increase the use of M2M-dedicated infrastructure elements instead of using existing data network elements to optimize M2M service offerings and to provide better QoS. This brings some infrastructure investment costs to MNOs, but with parallel use of existing infrastructure, the IoT-optimized infrastructure can be deployed gradually. Another concern is the availability of WWANs and wireless spectrum. Mobile networks are essential to geographically dispersed and mobile applications, which constitute a large part of objects in the IoT. Therefore, the penetration of both mobile networks and mobile terminals is vital for the growth of M2M and Internet of Things. Markets with limited mobile penetration require more infrastructure investments, and may be considered to be entered through joint operations with other MNOs. Furthermore, mobile spectrum is a scarce resource, of which managing should be assessed, because MNOs' future infrastructure investments depend on the allocation of spectrum (GSMA, 2013). While MNOs contribute to GDP through spectrum auctions, tight national spectrum allocation policies and their differences may limit the growth of IoT, and thus delay the GDP-reinforcing effect of the IoT.

Last, the Internet of Things is deeply dependent on robust and highly scalable energy infrastructure. Energy required by WSANS, for example, depends on the distribution of processing and communication frequencies. If most processing in WSANs is performed by middleware gateways, the energy requirements of wireless sensors are lower, than in a case of nearly independent wireless sensors embedded with service capabilities and communication interfaces. Similarly, if the wireless sensor is part of a critical application, such as a heart monitor, frequent data communication requires very high energy-efficiency and a secure supply of energy, whereas things communicating data once a month may operate long time periods with only small batteries. The performance of the future IoT is based on this flexible provision of energy, which may in some application areas have limitations. Zorzi et al. (2010) mention the importance of development in energy harvesting technologies. Without some kind of self-sufficiency in required energy, WSANs are dependent on either constant electricity connection or manual operation, such as changing batteries to nodes, which both may prove costly in large WSANs.

6.1.4 Market forces

The most impacting market forces MNOs encounter in the future IoT relate to dynamics of demand in the diffusion of IoT technologies, mostly open middleware platforms. In the technology adoption life cycle, the customer demand evolves from highly customized solutions, which transform customer's business, towards highly standardized, low-risk solutions, which are increasingly *needed* to adopt. Current M2M solutions MNOs are providing are quite customized, in a way that they are vertical-specific, and the machine-generated information stays within the boundaries of the vertical enterprise and its customers. M2M platforms have been the first step of lowering the risk of implementing M2M and horizontalizing the market with common components, thus decreasing the degree of costly customization.

In the future, the majority of companies adopting the IoT seek to gain value by connecting objects to the Internet and augmenting their whole value propositions with sensor-based information. The more pragmatic the adopters are, the more they want to keep the risks and costs of adoption low. By purchasing connectivity solutions and middleware platforms built on de facto standards and architecture lowers that risk. For MNOs this creates business opportunities in service enablement business area. Offering a uniform, IP-based and standardized IoT connectivity and service platform for vertical M2M users and 3rd party service providers would be a step towards the wider integration of M2M silos.

From end-user's point of view, the market is still largely comprised of isolated M2M solutions, despite the presence of platforms. The end-user demand for sensor-based information is likely to increase greatly in the IoT, as more applications are offered in multiple vertical application areas and the costs of technology are decreasing. Similar to business demand, end user demand of high technology products, such as IoT products, evolves towards increased standardization and productization in the industry. Innovators are more inclined to configure applications and purchase components themselves, whereas the majority of end users are more pragmatic. When a pragmatist buys an appliance, for example, he/she expects it to connect itself to the Internet without manual configuration or worries about interoperability between the appliance and network equipment at home. It can be estimated, that the demands of both enterprises and end users evolve towards standardization and low-effort purchasing after the Chasm. Furthermore, growing consumer markets for connected things and opens opportunities in both B2C and B2B2C marketing.

Of market forces, revenue potential also affects the core vision of an MNO. Machina Research (Hatton, 2013) predicts that in 2022 two thirds of IoT revenues comes from M2M devices and installation, while only one third is attributed to connectivity. Furthermore, M2M services comprise about 90% of connectivity revenues, leaving only ~10% to connectivity services inherently relevant to MNOs. Even from this residue, the majority of revenues are tied to service and connectivity platforms. (Hatton, 2013.) This leads to a situation, where revenue potential of plain data transferring is not a viable option for MNOs, because of decreasing mobile data revenues (Schlautmann et al., 2011). That is why M2M platforms are included in the service mix of operators now and also why they should be leveraged in the IoT business models in the future. By using a PaaS-model, MNOs can outsource the devices operation costs via the platform. Platforms remove the strenuous end-to-end integration process and reduce transaction costs of enabling M2M services to different verticals. For vertical customers, platforms offer service development, testing and provision environments in one, managed package.

By offering an IoT platform to vertical M2M users and 3rd party application service providers, the MNO evolves towards multi-sided platform business. Hagiu and Wright (2011) define a multi-side platform (MSP) as "an organization that creates value primarily by enabling direct interactions between two (or more) distinct types of affiliated customers" (p. 7). Although vertical M2M adopters and application service providers can interact directly in vertically integrated M2M applications, in the IoT, the platform's main purpose is to enable the information flow between vertical M2M users and non-predefined participants. The introduction of a horizontal service platform provides this information flow, and creates value to the participants in the value network. This is mostly due to positive network effects; application service providers gain access to resources provided by vertical industries and proprietary WSANs, and vertical M2M users enhance their relationships towards their customers via IoT applications. Furthermore, if the platform is introduced towards end users, the business model gains another side, and network effects are present between all three groups.

Therefore it can be hypothesized, that MNOs seek the revenue potential residing in the service enablement and platform business in the IoT, because service platforms offer MNOs way to integrate into the growing pool of value network participants and to gain revenues auxiliary to data transferring. The intermediary role of an MNO can be exercised through the use of a multi-sided platform business model, which leverages on MNOs' intermediary capabilities and network infrastructure.

The multi-sided platform approach results in segmentation based on differentiated value propositions to stakeholders. In the future IoT, MNOs will have two main customer segments: upstream customers, or vertical M2M users and downstream customers, or ASPs. Vertical M2M users use the platform to connect their "things" to the Internet, possibly via dedicated WSAN operators, and produce information based on physical things. The MNO provides the platform to abstract that information, and transform it into reusable resources and services, which then can be used by service providers. Service providers then offer IoT services to end users.

Because of network effects of multi-sided platforms (Osterwalder & Pigneur, 2010), accumulation of critical mass is difficult. Verticals do not connect their things to the Internet, if there is not a sufficient amount of service providers in the market, whereas service providers do not offer services, if there is not enough data available from vertical application domains. To surpass this "chicken-egg" problem, MNO could subsidize one of the sides to boost the adoption of IoT. In the Chasm, where the adoption decision shifts from technological buyers to economical buyers, long-term profitability and low risk of investment is demanded. Without reference groups from other companies, early majorities do not invest in the IoT, especially if the price of connecting objects is high. Subsidizing vertical M2M users and WSAN operators, id est., the sources of IoT data, with low-cost access to the platform and low cost middleware gateways could encourage them to adopt the IoT paradigm and abandon the M2M silos. Furthermore, subsidizing end users can increase the end user demand of IoT services and IoT applications. However, generating great margins from end users is not likely, because consumers' willingness to pay for information is generally seen as low. The segment generating the most revenue would then be the IoT application service providers. If the ASPs deem the platform adoption too costly, the

MNO has service development and provision capabilities, which it can use to substitute lower ASP adoption.

Although horizontal MSP-business model is not optimized for supporting niche strategies, such as the Bowling Alley, some kind of industry-based segmentation can help MNOs build the momentum required for the Tornado. For example, the MNO could begin with building an application domain specific ecosystem, where the Internet of Things is implemented between established M2M silos in that application domain, e.g. vehicular telematics. The diffusion of the IoT could then spread from these application-domains to adjacent application domains, as the relative advantage is communicated to other adopters. Selecting the beachhead segment is of importance, because the success of creating an interoperable marketplace for sensor based services inside a vertical application domain impacts the diffusion process to further verticals. The key determinant of success is the development of a robust ecosystem around open standards, and creation of vertical-specific APIs to the platform.

After both main customer segments start adopting the IoT paradigm, the strengths of horizontal platform business emerge in the Tornado. The early majority, or infrastructure buyers, adopts the IoT as the prevailing infrastructural paradigm, and they wish to be part of the market leader ecosystem. In this stage, the MNO concentrates in providing the same value propositions to its customers, broadening the market for its core platform connectivity business and leaving functions requiring deep customer intimacy to other participants of the ecosystem, e.g. the IoT service providers. Moreover, MNOs should maintain operator alliances and standards-led integration of distinct IoT ecosystems.

Last, as the paradigm diffusion moves to the late majorities, the IoT is starting to be a commodity among vertical industries. As Moore (1998) expresses, adopters of the late majority are more skeptic and price sensitive, which leads MNOs to finding additional revenue from the end users. Finding niches in the Main Street is difficult for MNOs, if the market is saturated with specialized IoT application service providers. In this case, MNOs concentrate on serving the B2C markets with the platform offering by, for example, offering smart home middleware gateways or connectivity tools to residential customers. For example, enabling the end users to build their own IoT applications using easy to use application development platforms could be one way of offering added value to end users. Another way is to leverage on the context information gathered from end users, such as location or communication statistics, and provide customized, context-aware services to end-users.

6.2 The core vision

Based on the estimations discussed in the previous subchapters, core visions of the MNO can be presented. The visions are divided into three parts as per three key stages of the technology adoption life cycle.

Table 2 Core vision

Life cycle stage	Core vision
The Chasm	MNO is an intermediary for companies *within* a vertical application domain, providing the connectivity platform for 3rd party service providers and vertical M2M users.
Early Majority	MNO is an intermediary *between* several vertical application domains, providing a connectivity platform for 3rd party service providers and vertical M2M users
Late Majority	MNO is an intermediary *between* several vertical application domains and end users of the Internet of Things.

The changes in the core visions can be paralleled with changing value disciplines. In the Chasm, the MNO pursues the value discipline of product leadership in order to gain critical mass for platform diffusion. Also, by gathering vertical-specific partners around the M2M user and providing vertical-specific APIs to the platform, MNO concentrates on customer intimacy value discipline.

As the platforms become adopted by early majorities in different vertical application domains, the role of the MNO is to widen the operational scale and increase the horizontal positioning of the platform. Keeping to the operational excellence value discipline is of importance in the Tornado, where verticals' demand exceeds the supply of the ecosystem. By leveraging operator alliances around the platform, geographical limitations of operator business are eased, and economies of scale emerge. Also leveraging on the ASP ecosystem spanning multiple verticals, the MNO can provide access to ready-to-market services without putting resources to service provision themselves.

In the diffusion to the late majority, MNO extends the customer intimacy towards end users of the IoT, and continues the use of operational excellence value discipline by offering IoT connectivity based on the de facto IoT architecture. The horizontal approach is used until the next paradigm shift possibly emerges, and the market abandons the IoT paradigm.

6.3 Future models

6.3.1 The Chasm

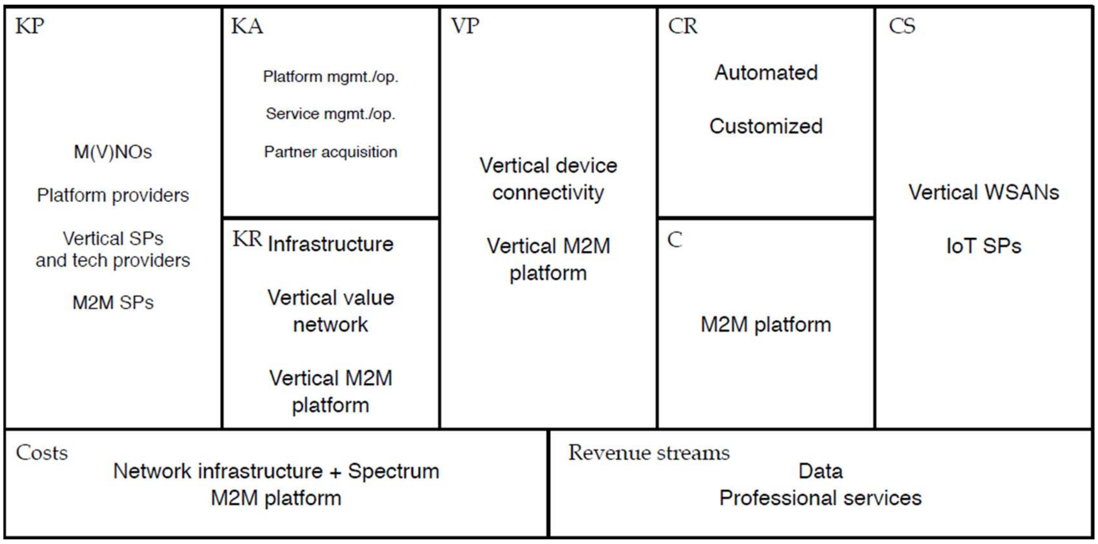

FIGURE 21 The Chasm

In the Chasm, the MNO business model centers on a single vertical application domain. For the vertical M2M users, the MNO offers a value proposition based on connectivity between established M2M elements (id est. vertical's devices and information systems), non-predefined vertical service providers and non-predefined end users. Furthermore, the vertical customer can use the same platform to provide services themselves, and differentiate from 3rd party service providers. WSANs in the vertical application domain can be also operated by WSAN operators, which intermediate between vertical M2M users and the MNO. The IoT end users are also a customer segment, to which the MNO offers wireless connectivity to the Internet.

By offering an IoT platform for a single vertical application domain, building an IoT ecosystem is easier, while it simultaneously serves as a test bed for wider IoT integration. This way, vertical concentration does not substitute established M2M business of MNOs. For vertical ASPs, the value proposition is the connectivity to vertical industries using a single contact point. The IoT platform opens them the access to vertical IoT information market without significant investments, and enables them to offer real IoT services to end users. Without MNO's intermediary role, few service providers could actually enter the IoT market at large scale.

In order for the first pragmatists in the vertical application domain to adopt the Internet of Things paradigm, the business model in the Chasm should be able to deliver a whole product. The vertical user, for example a vehicle manufacturer, receives value in form of information of its physical objects and their contexts via sensors. The core value can then be transformed to new services, or other sources of additional value. The basic product delivering that core value is the IoT connectivity solution, provided by the MNO. The expected product layer consists mostly of the IoT platform, which enables the vertical to create services, and manage their connected objects in WSANs. Support and other professional services are also expected from the MNO as part of the IoT solution. The MNO does not however control the trade of IoT services on the platform, but only offers trade support services.

The augmented service offering adds synergies of the emerging vertical IoT ecosystem to the value proposition. With a mutual open IoT platform, vertical enterprises can obtain information and compose services affecting and connecting multiple value chains into an IoT value network. Furthermore, the MNO can augment the platform offering by providing the vertical users middleware gateway technology, which speeds the diffusion of connectivity in vertical value chains.

The potential product is assurance of ecosystem growth and diffusion to multiple verticals, taken that verticals see the potential of IoT information crossing several vertical application domains. This information enables the development of more intelligent and aggregated services complementing the core businesses of verticals.

The value proposition in The Chasm (and the IoT in general) is structured around the multi-sided platform business model; for vertical M2M users MNO offers the platform, through which they can make their resources available as reusable IoT services. For IoT application service providers the MNO provides an IoT platform, on top of which they can develop their applications and services, and offer them to end users.

In the Chasm, the MNO should retain and improve the vertical M2M customer relationships already in place. With the platform offering, the vertical customer relationships are somewhat automated, but still based on long-term subscriptions requiring customized interaction. Integration of customer verticals' smart objects requires specialization, customization and extensive coordination with vertical partners.

The relationships with IoT service providers, however, are more dynamic. Vertical service providers as well as developer communities are given simple access to the platform with open APIs. The objective is to build an ecosystem of service profiders, where new applications and services are generated following the needs of the vertical application domain. Entry and exit to the ecosystem needs to be unobstructed for the service providers, in order to attract actors of various sizes and technological specialities.

To reach the IoT service providers, MNO offers them a unified channel: the platform APIs. APIs adhering to standards, such as IETF standards, enable the value proposition to service providers. Vertical M2M users, on the other hand, use the platform channel among other channels, such as professional sales and customer relationship management channels offered by the MNO.

The IoT platform is the key resource of MNOs, and its acquisition should be made with care and alignment with long-term IoT and infrastructure strategies. This means, that the IoT platform uses the capabilities of the network infrastructure, regardless of the generation of the mobile network infrastructure and backbone infrastructure. Coupling the standardized platform connectivity with location information, network optimization technologies and network QoS processes, for example, further emphasizes the role of the MNO in the Chasm, where these core capabilities contribute to the whole product provision.

The second important resource in the Chasm is the IoT ecosystem built around the vertical application domain. The social capital in IoT value networks enables the production of the IoT value proposition by bringing important core capabilities and additional resources to the value network. Core capabilities, such as vertical-specific knowledge and technologies, determine the composition of the value network, and create superior customer value to vertical M2M users.

To gain core capabilities, and to create superior customer value to both vertical M2M users and IoT service providers, the MNO maintains partnerships obtained in M2M business. IoT platform vendors are the most important of partnerships, because they are the key enablers of the MSP-business model. Partnerships can be tied with several platform providers, as has been done in M2M solutions markets, where the service enablement platforms and application enablement platforms can be acquired from different platform providers.

In the Chasm, the other key partnerships are attributed to the vertical application domain. Vertical technology providers, OEMs and service providers are important partnerships in the Chasm, because the larger the scope of value chain actors in the ecosystem, the better opportunities there are to create an interoperable vertical exchange of IoT services.

Last, the most important partnerships in the Chasm are the ones contributing to the interoperability between WSANs in the vertical application domain. Adoption of standards increases interoperability and decreases integration costs, which are seen as major adoption barriers by enterprise M2M adopters (Vodafone et al., 2013). Standards development organizations and network equipment/module vendors are needed to make the shift as an ecosystem from proprietary communication and identification standards to open standards compatible with the platform and middleware gateways. Forming alliances with M2M technology providers and other MNOs around same communication standards contributes to the emergence of de facto standards. Also multi-national MNO alliances expand the geographical operating barriers and increase the required wireless coverage. The objective of standards-led partnering is to build the ecosystem around the de facto standard, and gain market leadership in the first vertical application domain

Securing partnerships both in vertical and horizontal markets is favorable for the MNO, who needs to use the partner ecosystem and market share in the first vertical to create momentum to create the Tornado. If the first vertical application domain communicates the relative advantage of IoT platform connectivity to other verticals, the same ecosystem can be used to create value in subsequent application domains.

In the Chasm, the objective is to create a strong ecosystem around the vertical IoT platform business model, and it requires constant partnership acquisition and evaluation. Developing and operating an IoT partnering program directed to actors in the vertical application domain is the key activity required in this stage of the IoT diffusion, in addition to existing activities in the system reality. Management of the IoT platform and is also a significantly important activity for MNOs, because of platform's openness towards heterogeneous partners and customers.

Acquisition of the IoT platform incurs costs in the transition from M2M silos market to IoT market. Changing the M2M platform capabilities to IoT platform capabilities is done either by buying an IoT platform solution, if it exists, or developing M2M platform together with M2M platform provider partners. Either way, costs of the platform need to be taken into account.

Another cost of ramping up the vertical IoT is attributed to network infrastructure. M2M-dedicated network elements need to be installed to support connectivity of power-constricted objects and dense, urban or indoor environments. The beachhead vertical application domain needs to be offered a solution, which can be operated in all these environments. Furthermore, cloud storage capabilities needs to be invested in, because the amount of sensory information and its processing generates large amounts of data. Another option is to outsource the costs of data storage and processing to enterprise cloud storage providers.

Last, different revenue streams originate from customer segments of the MNO. Service providers pay fees for accessing the platform by either subscription or on a transaction basis. The platform fee grants the service provider the use of MNO's application development platform, APIs and access to vertical IoT service capabilities. Offering customized billing rates and platform SLAs to service providers increases customization in the business relationship, but grows the product dimensions towards the whole product.

In addition to data transferred, the vertical IoT user pays a service fee to the MNO for managing the connectivity of devices, enabling IoT services and providing support. The verticals can be subsidized with platform-compliant middleware gateways, which translate existing vertical-specific protocols to standardized protocols, also used by the IoT platform. With plug-and-play connectivity to service platforms and the market of 3rd party IoT application service providers, the adoption threshold is lowered, and furthermore, the speed to market is reduced because of lower integration costs.

6.3.2 Early majority

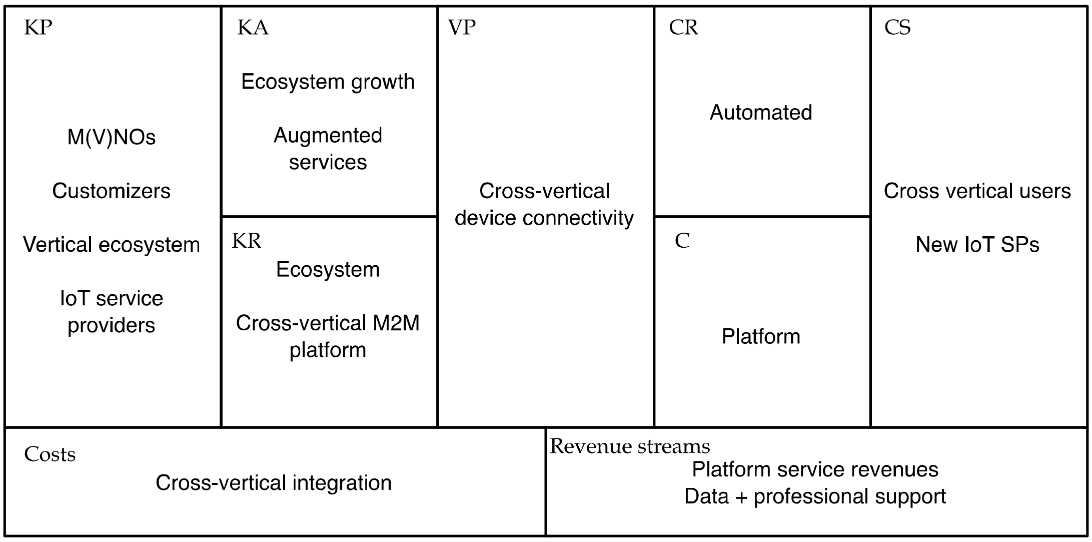

FIGURE 22 Early majority

When moving into the mass adoption of multiple vertical application domains, secluded M2M silos are replaced by the new IoT paradigm. To the mass market of vertical early majorities, MNO offers connectivity to the IoT, which opens the market for rich, synthesized and multi-use sensor-based information. The value proposition of the MNO is to offer connectivity through open IoT platform, which is used in multiple vertical application domains. The more distinct sensor networks are connected through open interfaces, the more value verticals receive, because of multi-usage potential of the information produced in WSANs. To new IoT service providers, access to information produced by WSANs in different vertical application domains represents value. The horizontal IoT platform creates them more business opportunities than in the Chasm, where business opportunities have limited to single vertical application domain.

Platform capabilities can be used as a vehicle in the bowling pin strategy, where a carefully defined niche is captured with a whole product offering. By shifting one, already served, vertical niche from bare vertical M2M towards the IoT with interoperable middleware and M2M platform capabilities, boundaries between vertical silos can be diminished.

Customer segments are provided direct interaction with each other through the IoT platform. Vertical M2M users and WSAN operators produce information to be used via the IoT platform, and it is used by IoT service operators, who generate value of their own without significant investments. MNO enables the creation of new, cross-vertical services for emerging and existing IoT service providers. Customer relationships are as automated as possible keeping the costs and threshold of joining the ecosystem low.

In the Tornado, the MNO concentrates on operational efficiency and all key activities requiring customization, are either outsourced to service partners, or automated using the IoT platform service capabilities. Key activity is to broaden the ecosystem from its vertical base.

The intermediary role between multiple vertical application domains enables the MNO to offer aggregated information services to SPs. IoT service providers can also use the platform service capabilities, and provide aggregated services themselves, but the MNO can augment the service with its core capabilities in billing, location services, mobile services provision and customer relationship management. In addition to IoT service providers and IoT users from different verticals, platform customizers and another MNOs are key partners in increasing cross-vertical and geographical coverage.

The key resource in the Tornado is the cross-vertical IoT platform, which is now marketed to vertical IoT users as a commodity infrastructure. Costs of adopting the platform must be relatively for both upstream and downstream customers, who in this stage are risk-averse. The second key resource is the ecosystem built in the previous stages of the diffusion process. The early majorities only participate in strong ecosystems, and market share, wireless network coverage and service development capabilities of ecosystems are evaluated carefully. The platform remains the key channel.

Main revenue streams come from selling the platform access to verticals following standardized SLAs. With economies of scale, the price of platform access can be driven relatively low, which increases the demand of price-sensitive majorities. IoT service providers generate revenue from end-users and pay a percentage to the MNO for platform usage.

Costs in this stage should be minimized, but some integration costs must be taken into account in integrating different kinds of vertical areas into the ecosystem and platform.

6.3.3 Late majority

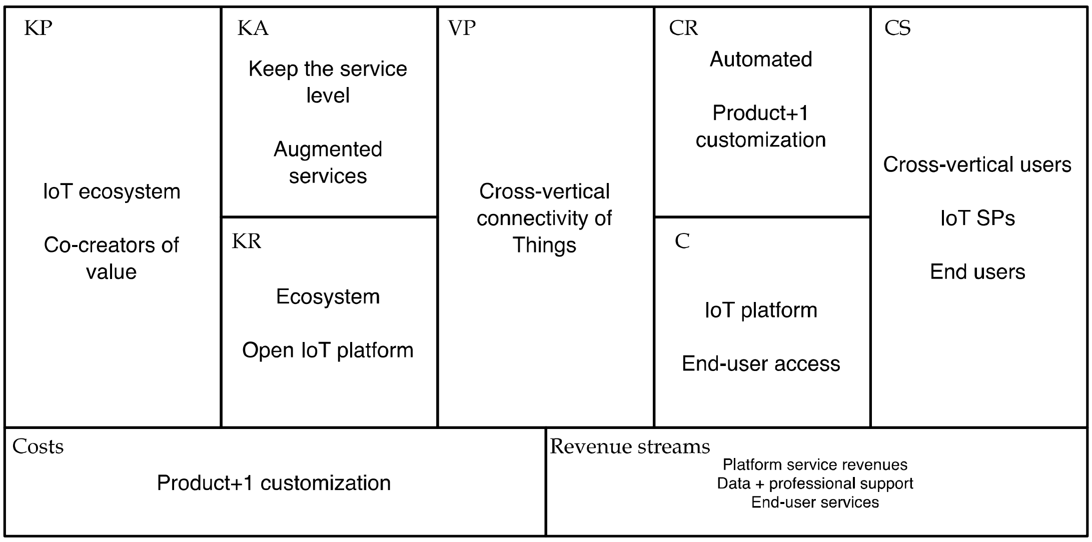

FIGURE 23 Late majority

Transitioning into Main Street moves the market strategy towards more cost-efficient business as well as price competition. The value proposition stays quite the same, except now MNO is the enabler of connectivity between virtually any connected thing and the service layer.

MNO can provide services directly to end-users, when the ecosystem has enabled easy access to Internet for common items. End-users can be offered services along their mobile device purchases or network subscriptions as a bundle, for example. This follows also the customer intimacy principle by giving end-users a single point of contact as opposed to multiple IoT service providers and the MNO. These customers can be provided access to the platform, which acts as a marketing channel, as well as a means to integrate anything into user's preferred network and its augmented services.

Key activities are keeping the service level as high as possible with minimal costs, and on the other hand, offer some customizations and augmented service offerings to carefully selected niches or end-users. The platform is the key resource, and continuing to keep it open and interoperable with standards is required as the ecosystem develops. The ecosystem defines the key partnerships in this stage, as more competitors have entered the market. Those partnerships, who can co-create value and augmented service offerings to service providers and end-users are of importance.

Changes in revenues and costs arise from B2C markets, where end-users are provided with new direct services and self-management of their own devices. Customization and customer relationship management may incur more costs, which can be covered with service revenues from end-users and new IoT service providers.

6.4 Comparison

As it is seen, the business models for each evolutionary stage are more specific than and not as inclusive as the system reality. Some components have fewer elements in them, and the perspective from which the business model elements are seen may vary. However, the future models present objectives, which are aligned on the level between corporate implementation and strategy.

Each future model tries to concentrate on a single stage, instead of trying to offer a little bit of everything to everywhere in the still emerging ecosystem. What the system reality and the future model of the Chasm have in common is the concentration on verticals. Although in reality, MNOs have specific solutions to multiple vertical industries, the future models suggest to use the bowling pin strategy, where a single vertical is used as a beachhead, before using the knowledge and positions gathered there and moving on to adjacent verticals. This vertical concentration is beneficial when market leadership is pursued in some of the vertical markets, which require the whole product of connected things.

The whole business model evolution presented here depends on MNOs' service platform. It is the key resource and channel in the future models, because without it, true interoperability and ecosystem openness, and low costs of integrating to it, cannot be pursued. Platform providers and MNOs have the most crucial relationship in all business models, but to avoid losing the advantage of the ecosystem, they must co-create value instead of trying to drive one another off the market.

As the key resource in the system reality is network infrastructure, its weight compared to the platform in the future business models is lower. MNOs need their infrastructure, but without the interoperable service platform, the existing network infrastructure does not reach its potential. Acquiring network coverage with network investments and spectrum auctions, especially in stages of the Chasm and early majority, is costly and partly mandatory. The coverage may be also acquired by contracting network partnerships with other MNOs, who simultaneously are competing in the same digital market. Market tensions will arise, when an MNO with a market leader service platform makes a market entry to new geographical markets. The entering MNO may either generate revenues by licensing the platform to the local MNO and lose service revenues in the market, or provide services in the market and pay for the local MNO's network usage. However, for many MNOs without strong market positions in the IoT, acquiring the platform from another MNO by licensing might generate revenues more than gathering network roaming revenues. In a larger perspective, the whole paradigm shift for MNOs leads to ecosystem-centricity and co-creation of value in value networks, rather than the old value chains.

As opposed to the system reality, where customer relationship management is a key activity, the future models suggest that customer relationships are automated by the service platform. Some degree of customer relationship management is needed, but the platform should create relationships ad hoc, when a service provider connects to it. Artificial intelligence should be capable of determining the appropriate service level for each service provider, and make possible adjustments to it if connected device configuration or the technology in the underlying subnetworks change. Supplier relationship and partner management, on the other hand, can be seen as a key activity, although many of its parts can also be automatized with the platform. Especially in the Chasm, optimal service levels need to be founded for each vertical partner, which then can be used in other vertical areas with little modification.

Revenue creation in the future is based more on the total value of the service than data traffic, and the objective is in ecosystem growth and customer relationships. This is seen already in the system reality, as MNOs offer professional services and end-to-end M2M connectivity solutions to some IoT users. This is emphasized more in the future, when data revenues get smaller, even though the number of connected things grows.

The Main Street brings the MNO business model a bit closer to the system reality by bringing the end-user to direct relationships with the MNO. The other possibility is, that independent IoT service providers are able to provide more value and service augmentation more cost-efficiently than MNOs, and remove them from the B2C equation. MNOs should therefore maintain the link between themselves and the end users, were it via data-only services or mobile device retailing. The best way is still to use the platform. With use of simple interfaces and standards of the platform, end users will have better ways of connecting their things to it, and possibly create value of their own by building applications and services themselves.

It must be noted, that there are no correct business models related to each stage of the adoption cycle. The guideline for operators should be consisting of several of these possible future business models, and they should be compared, analysed and implemented in the MNO's own ecosystem. One of the business models might be optimal for a life cycle stage, or the best result may be achieved by combining elements of all possible business models in the stage. The guideline implemented in a real MNO consists of real-world and financially based elements, which are company-specific.

6.5 Guideline to operators

The aforementioned differences between the system reality and possible future models uncover the key aspects of a rough guideline, with which the implementation of the possible business models can be approached in the IoT:

1. Acquire a service platform that is suited for operational excellence
2. Choose the vertical industry with the best value-creation core capabilities instead of potential revenue
3. Create, grow and nurture the ecosystem

The most important thing is to acquire the platform, most likely by partnering with a platform provider. Although the IoT is at first limited to a single vertical market, the platform should have capabilities to manage devices and things of a whole spectrum of services and technologies. Operating and customizing the platform may create costs in the early stage, but the less the need for integration and customization efforts, the more it can be used in creating value.

The decision on choosing the best vertical market in the Chasm should be based on the knowledge and value-creation core capabilities of the vertical. The growth in revenue awaits not in the first vertical market, but in the value network consisting of other verticals and application domains (bowling pins). MNO can leverage on some of its existing M2M business partners and customers, and try to provide the whole product to the first vertical customers first.

The value is not created by the MNO, but by the ecosystem. The core capabilities of the MNO and its partners determine the strength of the relationships and the value created for the customers. Therefore, the ecosystem should be easily entered and diverse, and the needed core capabilities should be managed by those, who do it best. Ecosystem growth is necessary, if the MNO pursues global, IP-based platform business. Partnering with another MNOs is required, and their existing core capabilities determine their places in the ecosystem. The ecosystem must also include other actors, such as standardization and information security organizations, which support the interoperability and security of IoT services.

7 Conclusions

The object of this research was to describe the possible futures and business models of an abstract MNO. First, the theoretical background was constructed using mostly academic literature. The key concepts were value and value networks, the business model and diffusion of technological innovations. Then, the methodological frame was presented and its conformity to research area and research questions was detailed. After that, both the technological and economic environment was described using material from both academic and non-academic sources. This description built the surrounding context, in which the system reality could be placed and on the basis of which the future could be researched. The future models were created and they were analyzed with and against the aforementioned system and its context. The result of this analyzation produced a rough guideline for an abstract operator to conduct business in the future Internet of Things.

Although not based on empirical, self-collected data, or primary sources, the research was grounded strongly on theory and publicly available data concerning the market of connected things, telecom industry and the modern, global technological environment as a whole. The future models presented can be discussed further, and most likely they do not describe the future accurately. Only time and the direction of development of the IoT ecosystem(s) shows, how accurate these models can be. Were they correct or not, they presented changes in business models, which can be taken into investigation in both academia and business, combined with specialized knowledge and other depictions of future.

Such an extensive use of the business model canvas in academic research can be argued, but here it served as an efficient, easily communicated and formal means of describing the area of research, which is the business model. The theoretical foundations of diffusion models support the use of simple presentation, and help the reader to easily combine these two concepts, diffusion and business models, together.

What was not covered in this research was the formal development program for MNOs, which would be the ultimate end product of the evolutionary futures research. Instead, this research provides the tools of implementation to building one. Development programs should be made in co-operation with the customer MNO, and it is a project decided not to include in this research.

Also few remarks were made to information security of the IoT. Many connected devices in multiple vertical markets have deficiencies in security, and data breaches can be made quite easily via connected household appliances, for example. If secure standards and communication protocols are not developed and used in device, middleware and network layers the whole paradigm of easily connected things may not reach its critical mass. It is critical for MNOs to participate in developing these safety measures, as it may also create new business opportunities for them.

Future research areas include creating and implementing some of those business model developments in a real or simulated market environment. From more technical aspect, more elaborated IoT platform requisites for MNOs could be researched, because of the major effect it has on the business models. The value-creating effect of the platform also gives birth to other research areas, for example researching the business relationships between MNOs and IoT-platform providers, and the evolution of interoperable interfaces and standards enabling the Internet of Things.

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