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Collaboration on Internet of Things Platforms

An Exploratory Case Study in the Swedish Automotive Sector Analyzing Volvo's Connected Car

Abstract

The automotive industry is going through major changes with the usage of connectivity in the car. The increasingly complex offerings cause companies to specialize, focus on their core strength and collaborate with other business players from different industries to stay competitive and innovative. Platform-centric business strategies evolve, which integrate the knowledge of different companies and facilitate collaboration between organizations. While the technical perspective on Internet of Things has received much attention, scholars have neglected the managerial perspective to this day. To profit from synergies and complementary resources, the dynamics of collaboration on Internet of Things platforms need to be addressed.

This study sets out to address this gap of collaboration on Internet of Things specific platforms by conducting an exploratory case study including a pre- & main-study analyzing Volvo's Connected Car. To explore how the collaboration between actors in Internet of Things based platform-centric networks is performed, a total of 21 interviews over two rounds were conducted. A theoretical framework based on research within industry convergence, platform-centric networks and inter-organizational collaboration was applied.

The study showed that static structuring devices are helpful but not sufficient to identify and describe collaboration patterns of actors on Internet of Things platforms. Collaboration must be differentiated within the platform according to use cases, separating actors according to specific offerings. Additionally, a dynamic view is necessary to characterize collaboration in different stages of maturity. Three collaboration patterns were identified: The Established Pattern, the Transitional Pattern and the Experimental Pattern. These patterns characterize the dynamics between the actors in the static use cases and outline varying collaboration settings, networks positions and roles as well as uncertainties in the collaboration.

This study advances the nascent research field of collaboration on Internet of Things platforms by emphasizing the dynamic dimension of collaboration and presenting three collaboration patterns scholars can build upon and practitioners can use to tackle challenges in this field.

Key Words: *Automotive, Collaboration, Internet of Things, Platform-Centric Networks, Open Innovation*

Authors: Thommen, Juerg (40698)

Wiechers, Benedikt (40704)

Supervisor: Per Andersson

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Stockholm, May 18th 2015

Juerg Thommen

Benedikt Wiechers

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Abbreviations

Acronym	Explanation
B2B	Business-to-Business
IC	Industry Convergence
IT	Information Technology
IoT	Internet of Things
OEM	Original Equipment Manufacturer
MRQ	Main Research Question
MVP	Minimum Viable Product
PR	Public Relation
R&D	Research and Development
SRQ	Sub Research Question
Volvo	Volvo Car Group & Volvo Car Dealers

Definitions

Concept	Explanation
Collaboration Patterns	Set of characteristics that describe the dynamics of collaboration between actors in a specific use case.
Dynamic	Always active or changing. (Merriam-Webster, 2000)
General Settings of Collaboration	The governance of collaboration: Ways in which co-ordination of inter-organizational collaboration is achieved and sustained. (based on Lowndes & Skelcher, 1998; Rhodes, 1997; Schleifer & Vishny, 1997)
Focal Actor	Coordinator of platform-centric networks, who provides key elements of the platform. (Enkel & Heil, 2014)
Industry Convergence	The blurring of boundaries between industries by converging value propositions, technologies or markets. (Choi & Valikangas, 2001)
Internet of Things	Worldwide network of interconnected objects uniquely addressable, interoperable and based on standard communication protocols. (Glova et al., 2014)
Network Position	The characteristics of the companys' relationships and benefits, obligations, rights and privileges that derive from them. (Ford et al., 2002)
Platforms	Products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their own complementary products, technologies, or services. (Gawer & Cusumano, 2014)
Static	Standing or fixed in one place, showing little or no change. (Merriam-Webster, 2000)
Uncertainties	Situation where the current state of knowledge is such that (1) the order or nature of things is unknown, (2) the consequences, extent, or magnitude of circumstances, conditions, or events is unpredictable, and (3) credible probabilities to possible outcomes cannot be assigned. (Holosko & Thyer, 2011)
Use Cases	All necessary activities to provide a specific customer offering in a platform sub-system. (based on Adolph et al., 2002; Bittner, 2002; Anderson et al., 2006)

1 Introduction

"The connection of vehicles and infrastructure is one of the mega trends within the automotive industry. Data is becoming more and more the oil of our era."
(Winterkorn, 2015)

The automotive industry is going through major changes with the usage of connectivity in the car. Increasingly complex offerings cause companies to specialize, focus on their core strength and collaborate with other business players in order to stay competitive and innovative (Easton, 1992; Ritter, 2000). This effect leads to collaboration across industries to enable above average innovative performance (Debackere et al., 2005). Platform-centric strategies evolve, which integrate the knowledge of different companies and facilitate collaboration between organizations (Enkel & Heil, 2014).

The introduction starts by explaining the background of this study (1.1), before describing the problem and purpose (1.2) leading to the main research question (1.3). Then the researched case is introduced (1.4) followed by the delimitation of the research scope (1.5). And finally, the study roadmap is outlined (1.6).

1.1 Background

Technological innovation happens at a rapid pace. Since its proposal in 1989 by Tim Berners-Lee, the World Wide Web grew and advanced continuously. There is no sign this development will slow down. On the contrary, an increasing amount of people around the world is getting connected. The increased connection is not limited to people, but also applies to physical objects, where more and more things are being equipped with sensors, receivers and micro-computers allowing them to connect, compute and communicate over the web. This recent development is expected to spread fast and connect up to 50 billion devices globally until 2020 (Ericsson, 2010). The increased connectivity demands collaboration across industry boundaries, resulting in industry convergence (Stieglitz, 2003). Multiple actors from different industries build together emerging technological platforms for variable reasons and interact on multiple layers (Turber et al., 2014).

The resulting industry redefinitions and transformations have large implications on how business is conducted. Substitutes emerge from before disconnected sectors (Weavers, 2007) and the value chain gets redefined into value networks with powerful network effects (Gawer & Cusumano, 2014). The basic phenomenon driving many of the changes is the IoT, a major recent technological phenomenon that is driving industry convergence with impact on objects, interactivity and technology approaches, and further blurring the line between the real and virtual world (Vermesan & Friess, 2013).

By connecting various objects throughout the whole environment and allowing them to communicate between each other without human interaction, complex and interlinked new business opportunities become possible. A major challenge for IoT projects will be to realize the business potential that is seen in the integration of multiple businesses operating in collaborative environments while maintaining data integrity and clarifying data ownership and value appropriation issues at the same time (Pentland, 2014). Emerging from this challenge are new technological based platforms, which involve new collaboration patterns between multiple businesses.

1.2 Problem and Purpose

To understand which collaboration patterns between firms occur as a consequence of the emergence of new IoT based technological platforms, different theoretic fields must be considered to do justice to the complexity involved: (1) Industry convergence caused by technological advancement like IoT, (2) inter-organizational collaboration and (3) platform-centric networks.

While collaboration in networks is a well-researched topic, it stays very complex due to the many actors and dynamics involved (Gemünden & Ritter, 2003; Sousa, 2014). Literature about collaborative platforms exists (Gawer & Cusumano, 2014; Enkel & Heil, 2014), but the combination of collaboration on technological platforms in the IoT context is scarce (Yoo et al., 2012; Turber et al., 2014). Even when looking at Internet of Things literature in general, there is very little research available outside the field of engineering or computer and data science (e.g Atzori, Iera & Morabito, 2010). Therefore a clear need exists for research in the field of collaboration in IoT platforms.

The purpose of this study is to contribute to the existing literature by developing knowledge about collaboration patterns emerging as a consequence of IoT based technological platforms.

1.3 Main Research Question

The lack of research on collaboration patterns on IoT based technological platforms leads to the main research question:

MRQ: What new collaboration patterns occur as a consequence of the introduction of new Internet of Things based technological platforms?

1.4 Case Selection

The car as a very complex construct represents an interesting and quickly developing field in the landscape of IoT (Telefonica, 2014). More and more, cars start to resemble computers on wheels and are connected to the outer world by a cellular network (Aboltins & Rivza, 2014). Connectivity, meaning the connection of the car as part of the Internet of Things to generate and process data, is omnipresent in the automotive media and seen as a game changer from leading industry figures and experts:

"The car will be another platform to cover different aspects of life. Big data will need to be processed properly for us to maximize the benefits, but this is also a good opportunity to collaborate across companies and industries."
(Luan-Na, 2013)

Increasing mobility, transport as a service (e.g. leasing, renting, sharing), the latest information technology advancements (e.g. autonomous driving, connectivity) and frequently updated austere regulations on national and global level (EPA, 2015) lead to fundamental change within the automotive industry. The resulting value networks are different from the traditional value chains where the automotive manufacturer needs to work together with vast numbers of supplier to create the final offering (Enkel & Heil, 2014; Gawer & Cusumano, 2014).

The collaboration and changes within the automotive landscape, involving manifold actors from different industries (AutoScout24, 2014; Ericsson, 2014) make it an interesting research subject to examine collaboration patterns of IoT platforms.

The examined case in this study is the IoT platform of Volvo's Connected Car. The platform is the result of many actors collaborating together to connect every new Volvo Car with different actors inside and outside of the organization. By building the hardware requirements in the car, connectivity is enabled and can be used for manifold purposes: Communication, entertainment, maintenance, navigation, information, safety, support and more (Volvo Cars, 2015). Beginning with the new Volvo XC90, the newest generation of the Volvo Connected Car system will be available in every new Volvo model, allowing connectivity functions (Volvo Cars, 2015).

Volvo's Connected Car was chosen because of the great visibility of two key actors (Volvo & Ericsson) in close proximity of the researchers' facility. Also the cultural environment and an open and helpful mentality in Sweden allow easy accessibility of key persons within an organization. In combination with Swedish regulations and laws this leads to a high degree of available information compared to other countries.

1.5 Limitations

To allow focus on new collaboration patterns on IoT based technological platforms, this study possesses two limitations that need to be considered:

Customers were excluded as a research object. For the study, the scope of the analyzed actors is delimited to B2B level only, considering the OEM and car dealers as one unit for simplicity reasons (in this study named Volvo).

Focus lies on Volvo as the main actor of the platform. By manufacturing the cars, Volvo builds the base of the platform and is essential for platform survival. Volvo acts as a central gateway for all other actors involved and controls the platform. These circumstances indicate that Volvo has a big impact on collaboration and collaboration patterns on the Connected Car platform.

1.6 Study Roadmap

This section presents the structure of the study:

2. Pre-Study

The second chapter contains the pre-study with the purpose of narrowing down the research focus by identifying key aspects of collaboration patterns that are essential to explain the main research question.

3. Theoretical Foundation

The third chapter presents relevant literature in the field of industry convergence, platform-centric networks & inter-organizational collaboration and sums up the underlying theoretical framework of the main study. Furthermore the research gap is addressed and elaborated.

4. Methodology

The fourth chapter introduces the methodological approach including research strategy, design, reliability and validity and lists important limitations.

5. Empirical Findings

The fifth chapter presents the empirical findings. The actor network with its involved actors is showcased and the examined use cases are described.

6. Analysis

The sixth chapter analyzes the empirical findings by connecting them with the theoretical framework and applying relevant theory.

7. Conclusion

The seventh chapter summarizes the conducted study.

8. Discussion

The eighth chapter discusses implications of the study and shows fields for future research.

2 Pre-Study

The purpose of the pre-study is to specify the main research question and narrow down the research focus on key aspects that are essential to explain the main research question: The detection of collaboration patterns on IoT based platforms. In addition, collaboration partners are identified.

As a starting point for this research, the method of semi-structured interviews was applied. The method was chosen because of the exploratory nature of this study that deems this qualitative methodology appropriate (Bryman, 2012). Six interviews were conducted during the pre-study with duration of 35 to 70 minutes each. The sample of interviewees included participants from three different companies (Continental, Ericsson & Volvo), working on different strategic levels (Senior Vice President, Vice President, Principal, Team Manager) and within different functions (Strategic & General Management, Sales, R&D and In-House Consultancy).

All semi-structured interviews were conducted based on an interview guideline. To give the guideline a clear, logic structure, we chose the framework of Turber et al. (2014). This framework is one of the first that combines elements of platform-centric collaboration with the specifics of IoT environments. According to Turber et al. (2014), platforms are created by the inter-organizational collaboration of complimentary involved actors that are incentivized by technological developments and resulting industry convergence to participate in the build-up and maintenance of the platform.

The framework of Turber et al. (2014) spans a grid with three dimensions ('Who', 'Where', 'Why') to depict the actors within the platform (see Figure 1). The pre-study interview guideline is structured accordingly (see Appendix 3).

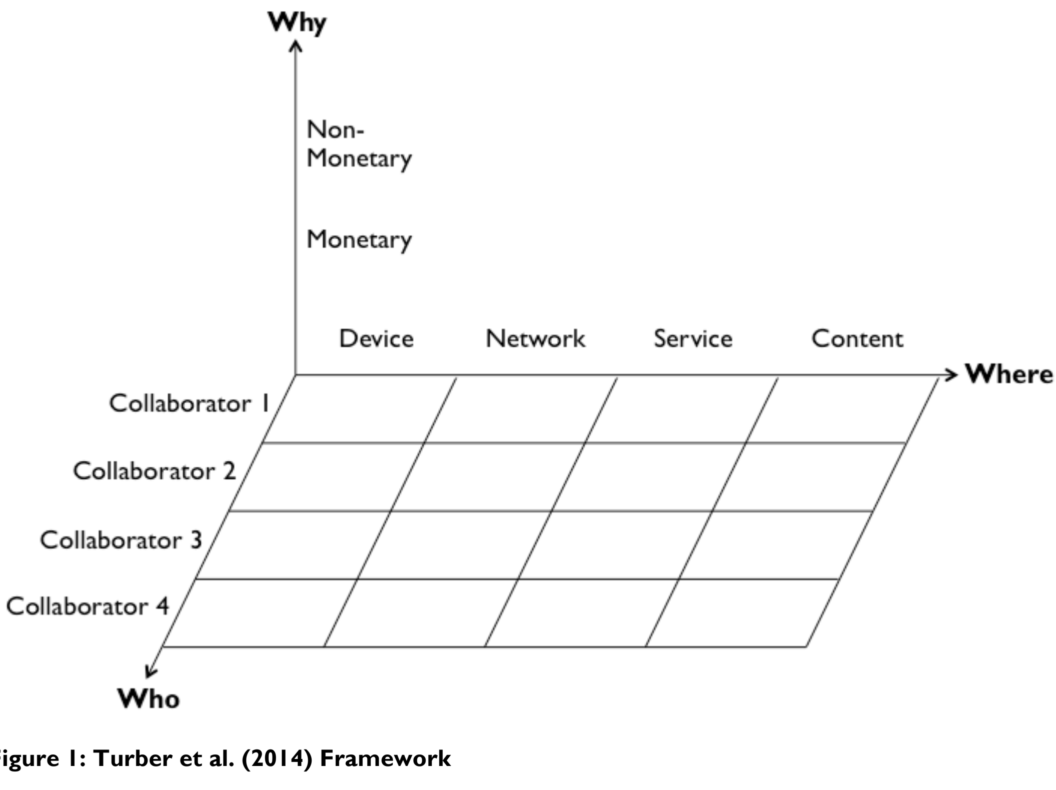

Figure 1: Turber et al. (2014) Framework

The 'Who' dimension encompasses all participants of an IoT ecosystem circling around a digitized product.

The 'Where' dimension describes the places of value creation by the involved actors and is divided according to the four-layered modular architecture of digitized products stemming from information system research (Yoo et al., 2010). "The device layer comprises hardware, which can be any kind of devices, and an operating system to control the hardware; the network layer involves both the logical transmission plus network standards, and the physical transport; the service layer features direct interaction with the users through application programs, e.g. as the users create or consume content; the content layer hosts the data, such as texts, images or meta-data like geo-time stamps." Each layer represents "a distinct source of opportunities for collaborators to contribute to the value creation process" (Turber et al., 2014, p. 26).

The 'Why' dimension outlines the reasons for each actors to participate. These benefits are divided into monetary and non-monetary benefits.

Through the interviews, eleven actors involved in Volvo's Connected Car Platform were identified with Volvo as the focal actor. These actors were sorted into the Turber et al. (2014) framework:

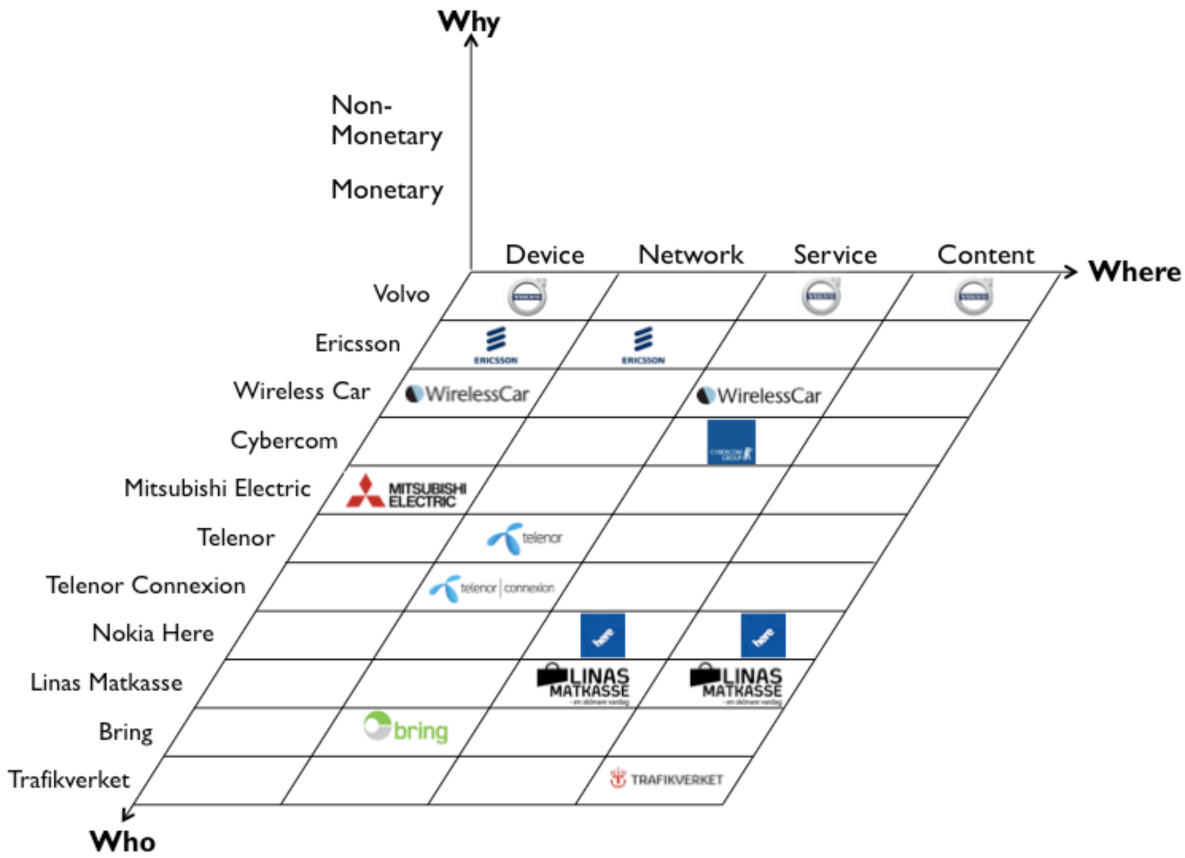

Figure 2: Volvo's Connected Car Platform in the Turber et al. (2014) Framework

Figure 2 only focuses on the 'Who' and 'Where' dimensions. The 'Why' dimension added little value for identifying actors and key elements for collaboration patterns while unnecessarily increasing complexity at the same time. Turber et al. (2014) suggest themselves that the 'Why' dimension only "allows for a rough picture on each collaborators benefits" (p. 29).

In the 'Who' dimension, two kinds of players were identified within the network: First, the actors that constitute the platform itself within the Volvo cars. These actors are Volvo, Ericsson, Wireless Car, Cybercom, Mitsubishi Electric, Telenor, Telenor Connexion and Nokia Here. Second, actors that build upon the existing platform with additional offerings. These are Linas Matkasse, Bring and Trafikverket.

In the 'Where' dimension the different actors operate on different layers: Volvo, Mitsubishi Electric, Ericsson and Wireless Car act on the device layer, providing hardware and the operating system to control the hardware. Ericsson, Telenor, Telenor Connexion and Bring act on the network layer, providing logical transmission of data and physical transport. Cybercom Group, Linas Matkasse, Volvo and Wireless Car act on the service layer by directly interacting with users through application programs. Nokia HERE, Linas Matkasse, Trafikverket and Volvo act on the content layer, hosting text data, image data and meta-data like geo time stamps. (Turber et al., 2014)

The 'Why' dimension outlines each actors "reasons to participate in the ecosystem" (Turber et al., 2014). Primary, monetary reasons for collaboration were named. Secondary, gaining capabilities and knowledge, defending the market position and creating and using new opportunities were stated as non-monetary benefits of participating.

The pre-study has shown that the mapping according to Turber et al. (2014) is useful to visualize the platform and identify actors and their place within the grid. Being a static device, the framework is not sufficient to explain what the involved actors do in their interactions. Collaboration is a sequence that develops over time. Modern system theoretical approaches focus strongly on the description of processes and sequences (Luhmann, 1984; Bateson, 1972). This process dimension is missing in the Turber et al. (2014) framework, but is crucial to identify and describe collaboration processes and patterns. In recent platform-centric collaboration literature, the platform is described as a facilitator of collaboration, rather than a product of collaboration, emphasizing the process of collaboration between the actors (Enkel & Heil, 2014; Jiao et al., 2005).

The study therefore dives deeper into the process of collaboration to understand 'How' the collaborating actors interact and 'How' collaboration patterns can be described (see Figure 3).

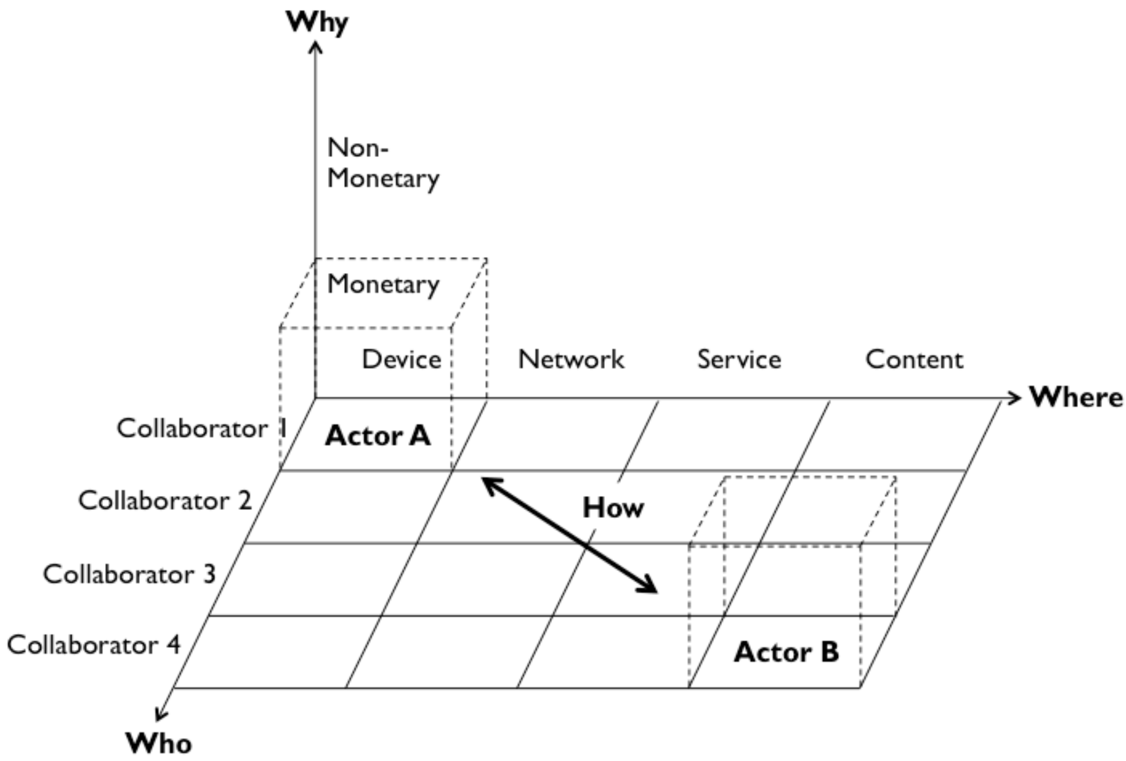

Figure 3: Turber et al. (2014) 'How' Dimension Extension

All involved firms participate in collaborative innovation activities due to the novelty of the platform and IoT technology in the automotive field (Stieglitz, 2003). The platform is created and develops in a co-evolutionary process of the collaboration of the participating organizations, which is in line with evolutionary economics (Boulding, 1982; Hodgson, 1994). The participating actors on the platform form the platform foundation or build upon it with additional offerings, therefore can't be seen as one platform-wide group.

Sub-groups on the platform exist that collaborate to create specific offerings. Depending on the specific offerings the actors are creating, the collaboration has different characteristics. The collaborations on specific offerings are sub-systems of the whole platform. In the study at hand, those sub-systems are called use cases, which are defined as all necessary activities to provide a specific customer offering in a platform sub-system (based on Adolph et al., 2002; Bittner, 2002; Anderson et al., 2006).

All pre-study interview partners confirmed that the collaboration differs depending on use case, indicating high empirical saturation:

"The connected car itself is worthless. No one pays for the connected car. People only pay for use cases. That means tangible customer value." (Interviewee[03], 2015)

"Volvo basically is the actor here that knows about the use cases […] we're helping them realizing their use cases one could say." (Interviewee[04], 2015)

"That [the ways of collaborating] is very very much depending on the different service providers. Its different from case to case actually." (Interviewee[05], 2015)

To identify and describe specific collaboration patterns on the IoT platform, the main study examines specific use cases on Volvo's Connected Car platform.

Besides identifying actors, the purpose of the pre-study was to detect key elements that lead to the identification and description of collaboration patterns. From the six interviews, three elements stood out: General settings of the collaboration, network positions and roles of actors and uncertainties in the collaborations.

General settings of the collaboration were described as crucial to facilitate and regulate the collaboration and to handle uncertainties. Those settings include the legal framework, processes, procedures and general rules, tools and frameworks used to set up the basis of the collaborations.

"The most important thing is probably actually setting up all the infrastructure that you need for all of this." (Interviewee[05], 2015).

"Challenges are the legal aspects and the framework for the collaboration. That's because different industries work according to completely different rules." (Interviewee[03], 2015).

The first sub-research question to examine general settings of collaboration is:

SRQ 1: How do actors within use cases define the general settings for collaboration?

Network positions and roles of actors may shift between use cases by companies taking on different role in the platform-centric network.

"That is the most important topic regarding the connected car. To move away from traditional business structures. And to opportunistically adapt to use cases and to the necessity to bring certain topics to life." (Interviewee[03], 2015).

"And that means that a lot of players will have changed roles, bigger or smaller within the connected car ecosystem." (Interviewee[01], 2015).

The second sub-research question to examine network positions and roles of actors is:

SRQ 2: How does the focal actor's network position and role change between the use cases?

Uncertainties in the collaborations were named as the root cause of arising challenges. Several uncertainties were mentioned about producing the right product in the right way in a complex environment.

"The challenge is of course to find the most compelling and attractive customer offering on the different markets and do this right." (Interviewee[01], 2015)

"You need to get an understanding of the demands of the market." (Interviewee[03], 2015)

"We don't really have done it before. Nobody has really. And you need to invent new processes and new ways of thinking about things to make it work." (Interviewee[05], 2015)

The third sub-research question to examine uncertainties in the collaborations is:

SRQ 3: What are the main uncertainties within each use case and how do the actors handle those?

Those three specific sub-research questions are used in the main study to identify and describe collaboration patterns in use case specific collaboration on Volvo's Connected Car platform. In chapter 3 theory complementing the pre-study findings is outlined.

3 Theoretical Foundation

The literature review provides an overview of how the theoretical framework for the study is developed. An overview about industry convergence (3.1) is given to provide the entry point and the fundamentals for this research. To provide an in-detph understanding of collaboration patterns, the research field of platform-centric networks and collaboration in networks are introduced (3.2). Then the derived research gap is shown (3.3) and the theoretical framework outlined (3.4).

3.1 Industry Convergence

The IoT phenomenon is the technological driver that leads to the collaboration of different actors across industries. In this chapter, the convergence of actors from different industries is defined and its background described before showing driving factors contributing to the convergence effect.

Definition & Background

The term industry convergence goes back to Nathan Rosenberg, who described the development of the machine tool industry and recognized technological transfer between the tool and the weaving industry (Rosenberg, 1963).

The term industry convergence is often "used to characterize industrial dynamics in the new digital economy" (Stieglitz, 2003) but is seldom clearly defined (Katz, 1996). To define industry convergence, it is useful to take a look at both terms that constitute the notion. Companies are said to be in the same industry when there is a "substitutability of their products" (Geroski, 1998). Substitutability is given when the products satisfy the same customer needs (Abbot, 1955). Alternatively an industry can be defined as "a group of firms that produce products and services that are close substitutes and who supply a common group of buyers" (Bain, 1968). Convergence is understood as "the movement towards the same point or the meeting of two or more elements" (Merriam-Webster, 2000).

Therefore, industry convergence in this study is understood as "the blurring of boundaries between industries by converging value propositions, technologies or markets" (Choi & Valikangas, 2001), "two or more previously distinct industries converge when the firms in those industries become direct competitors" (Malhotra & Gupta, 2001).

Different kinds of categorization on industry convergence exist in literature. Mainly a distinction is made between technology-driven or input-side convergence and market-driven or output-side convergence (Bröring & Leker, 2007). Another classification splits industry convergence into convergence in substitutes and convergences in complements (Weavers, 2007) or even compares both dimensions into a matrix (Stieglitz, 2003).

Industry convergence can have both, positive and negative effects. For some companies it implies new opportunities and growth while other might suffer from consolidation and shakeout (Hacklin et al., 2009; Lee et al., 2010). In any case industry convergence induces a lot of movement and increases dynamics (Bierly & Chakrabarti, 1999) through the fusion of "demand structures and the combination of previously distinct product features into hybrid products" (Pennings & Puranam, 2001; Sääksjärvi, 2004), technologies, standards and regulations (Katz, 1996). These characteristics together with new competition (Bröring & Leker, 2007) lead to a high degree of uncertainty for the involved companies who need big absorptive capacities to adapt quickly to changing conditions (Cohen, 1990) through new sources of knowledge, competencies and resources (Bröring & Leker, 2007).

Driving Factors

There are many factors that favor industry convergence, but the invention of technology with increasingly rapid technological shifts is probably the most important one (Stieglitz, 2003). Others are regulation and standards, business model innovation, process innovation, changing customer requirements, corporate diversification strategies and change in industry channel structure (Weavers, 2007; Stieglitz, 2003). On a macro economic level, globalization and digitization are important contributors (Lee et al., 2010). Innovation often emerges at the intersection of established industry boundaries (Hacklin et al., 2009). Through digitization, globalization and entrepreneurial managerial creativity (Yoffie, 1997) is not bound geographically any more.

Hindering factors for industry convergence can be strategic alliances, joint ventures and mergers and acquisitions (Weavers, 2007) in which companies engage to preserve the status quo. This organizational inertia (Duysters & Hagedoorn, 1998) can slow down the impact industry convergence has on the core competencies of industries. Companies keep their initial organizational form unless the benefits of giving in to the convergence are bigger than the stability of the traditional form and core competencies.

Industry convergence driven by the technological phenomenon of IoT leads to cross industry collaboration and increases industry convergence (Stieglitz, 2003). This in return affects how organizations collaborate.

3.2 Platform-Centric Networks & Collaboration in Networks

In this chapter inter-organizational collaboration within platform-centric networks is explored by looking at literature about collaboration and interaction between organizations. First, this chapter focuses on platform-centric network architectures (3.2.1) and collaboration in networks (3.2.2) to understand the framework the actors navigate in, before looking at the innovative activities they perform within the network in form of open innovation (3.2.3).

3.2.1 Platform-Centric Network Architectures

This study follows the line of thought of the Industrial Marketing and Purchasing Journal (IMP). This research forum focuses on business interaction, relationships and networks and describes the business world as "populated by a multitude of firms, which develop and sustain among themselves both aggregates of discrete transactions and ensembles of inter-related cooperative relationships (i.e. markets and networks respectively)" (Sousa, 2014, p. 13). The Industrial

Marketing and Purchasing research forum operates under the basic assumptions that you can't see organizations as "islands of conscious power in an ocean of unconscious cooperation" (Robertson, 1923, p. 85) or as "autonomous units buying and selling at arm's-length in markets" (Richardson, 1972, p. 883). One frequently discussed field in recent academic articles operating under this assumption is platform strategies. In basic terms, companies can create value when bringing a network of complementary organizations together and facilitating their collaboration on a platform. The platform can be used to integrate the knowledge of all organizations and to facilitate transactions between these platform users (Enkel & Heil, 2014). Various researchers have used the term platforms and analyzed it from various angles for example in the field of new product development and operations management (Lehnherd & Meyer, 1997; Jiao et al., 2005), in technology strategy (Cusumano & Gawer, 2002; 2008; Eisenmann et al., 2006; Gawner & Cusumano, 2002) and in industrial economics (Armstrong, 2006; Evans, 2003; Rochet & Tirole, 2003). Gawer & Cusumano (2014) have divided the platform types in internal (company-specific) platforms and external (industry-wide) platforms. The focus of this paper is on external platforms and follows the definition of Gawer & Cusumano: "Platforms are products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their own complementary products, technologies, or services" (p. 417).

External platform-centric network architectures are at the core of many recent successful companies like Apple, Google, AirBnb and Uber. The strategic relevance of those platform solutions is also high for traditional industries that want to offer fully integrated solutions, which otherwise cannot be handled alone without taking high risks and investing many resources. One example of a platform-centric network is Volvo's Connected Car.

The novelty about platform-centric views on networks is the shift from value chains towards value networks. Single steps of former static value chain processes can get disconnected and then reassembled again into a flexible, integrated system of resources and capabilities involving multiple firms, each firm or actor taking on a different task. In the end there is not a single firm facing competition, but a network of specialized firms with wide-ranging and specialized resources and capabilities (Enkel & Heil, 2014). Thereby, the platforms enable powerful network effects (Gawer & Cusumano, 2014).

Platforms can be seen as the economic 'breeding grounds' for the whole network. A focal player provides the core elements of the platform (Enkel & Heil, 2014). The platforms can be differentiated between industry platforms and multi-sided platforms (Gawer & Cusumano, 2014). Enkel & Heil (2014) add the mixed form of multi-sided industry platforms:

On 'Multi-Sided Platforms' the focal player only facilitates transactions between different parties, but does not participate in the complimentary development of the network (e.g. Ebay).

In contrast, 'Industry Platforms' have a strong focal player as platform owner, who integrates the complimentary innovations of the other involved actors. The focal player has control over the interaction with the end-customer and the revenue stream (e.g. Daimler Car2Go).

'Multi-Sided Industry Platforms' then combine the facilitation of transaction and integration of complimentary innovation (e.g. Apple & App Store).

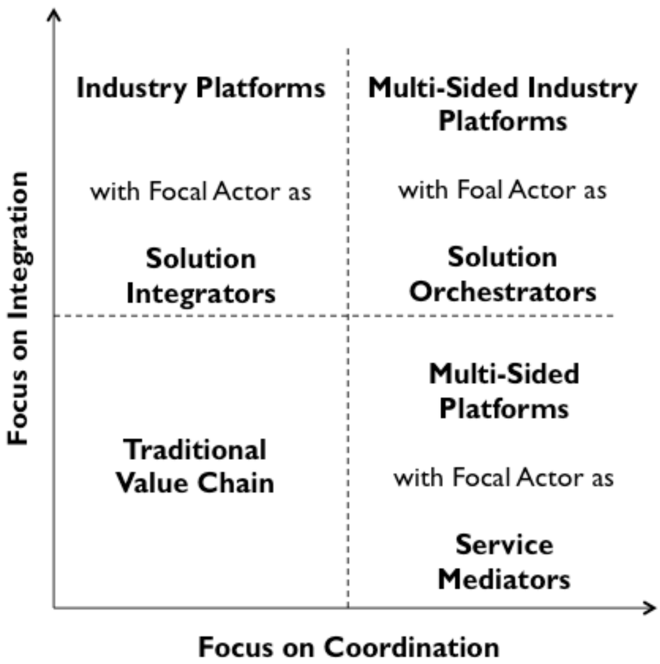

Figure 4: Platform Types and Strategic Network Roles of Focal Actor (Enkel & Heil, 2014)

For each of the three platform types, Enkel & Heil (2014) describe specific strategic network roles (see Figure 4):

Multi-sided platforms are usually built by 'Service Mediators' that focus on service coordination between actors and which try to add new value creation steps into the existing value chain.

Industry platforms in contrast rather see 'Solution Integrators' that try to complimentary enhance their own business models through cooperations, joint ventures and acquisitions.

Multi-sided industry platforms then require 'Solution Orchestrators' that create an innovation ecosystem by integrating and combining complementary actors. Through their coordination efforts they facilitate competitive advantages for themselves and all involved actors (Enkel & Heil, 2014).

3.2.2 Collaboration in Networks

Looking on individual organizations in detail, firms can be described as a heterogeneous bundle of resources and capabilities (Penrose, 1959). Within this resource-based view of the firm resources and capabilities can form and sustain the competitive advantage of a firm (Grant, 1991; Wernerfelt, 1984). At the same time, resources and capabilities also form the boundaries of the organization. The limited set of resources and capabilities force companies to come to the boundary decision: make, buy or cooperate (Sousa, 2014; Jacobides & Billinger, 2006). This decision is crucial when considering that research showed increased productivity through specialization (Smith, 1776; Young, 1928; Stigler, 1951). Therefore companies cannot be monogamous and need to develop relationships with other organizations. Additionally, business markets are becoming more complex and "firms access resources not only through suppliers and customers but also through banks, shareholding institutions, government, distributors, consultants, associations, etc." (Easton, 1992; Ritter, 2000, p. 317). This effect is expected to increase further since inter-organizational collaboration indicates a higher innovative performance (Debackere et al., 2005). These are arguably the main reasons for inter-organizational collaboration and why firms need to be seen as embedded in networks. Firms are semi-autonomous and "deeply entangled in a variegated texture of economic, social and technological linkages with multiple counterparts" (Sousa, 2014, p. 15). Especially due to technological advancements like the digitalization, value creation processes are not following a linear process within certain industries any more. The boundaries of the companies and their industries become more diffuse. This development leads to the necessity of inter-organizational and inter-industry cooperation with complementary companies that provide solutions and use case specific resources (see chapter 3.1). Complementarity becomes more important than competition through the development of synergies: A co-evolution of firms takes place with the collaborative use of platforms (Boulding, 1982; Hodgson, 1994).

A mayor finding of the extensive research in the field of inter-organizational interaction was the 'discovery' of connectedness, saying that relationships do not exist in isolation or independent from each other, but rather that one relation is "contingent upon exchange (or non-exchange) in another relation" (Cook & Emerson, 1978). The "generalized connectedness of business relationships implies existence of an aggregate structure, a form of organization we have chosen to qualify as a network" (Hakansson & Snehota, 1995; Gemünden & Ritter, 2003). Hakansson & Snehota (1995) define networks as "a structure without one center of gravity where components are connected in an open mesh" (p. 269). No single firm can manage, design, or run networks on their own, since all activities in a network depend on what the other actors do (Ford & Saren, 1996; Ford D. , 1997; Gemünden & Ritter, 2003). Research has shown that networks can be described in terms of actors, activities and resources and that these elements influence each other (Hakansson & Johanson, 1992). Actors perform activities and control resources. Activities transform resources and are used by actors to achieve goals. Resources give actors power and enable activities (Gemünden & Ritter, 2003).

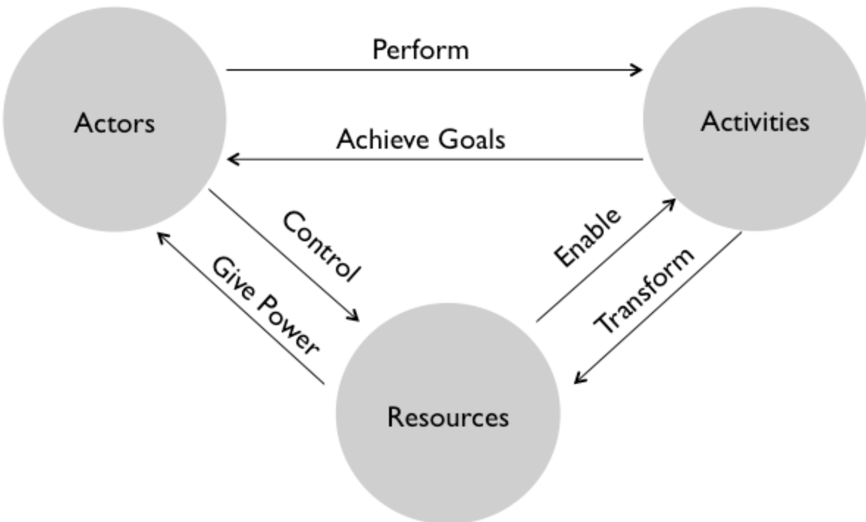

Figure 5: Network Elements and Influencing Factors (Hakansson & Johanson, 1992)

Derived from these dimensions, the profile of a one-to-one business relationship between two companies can then be assessed by three effect parameters (see Figure 5): (1) Activity Links, (2) Aesource Ties and (3) Actor Bonds (Hakansson & Snehota, 1995).

- **Activity links** are technical, administrative, commercial and other activities of a company that can be connected in different ways to those of another company, as a relationship develops.
- **Resource ties** connect various resource elements (technological, material, knowledge resources and other intangibles) of two companies. They result from how the relationship has developed and represent in itself a resource for a company.
- **Actor bonds** connect actors and influence how the two actors perceive each other and form their identities in relation to each other. Bonds become established in interaction and reflect the interaction process.

Consequently, networks consist of many of these one-to-one relationships (Hakansson & Snehota, 1995). In order to analyze relationships, the level of analysis needs to be differentiated. Mattson (1997) differentiates three levels: The micro-level (dyadic relationships between two firms), the meso-level (the net of an actor with all its relationships) and the macro-level (reviewing whole markets as networks). Ford & McDowell (1999) and Möller & Halinen (1999) add 'the Portfolio' as a fourth dimension between the micro- and the meso-level. In this dimension a single firm is chosen as a starting point (usually called the focal firm) and then a subset of relationships is analyzed. Thereby, not all relationships of a firm are analyzed (as in the meso-level), but rather similar relationships are taken together. This is also the perspective that this study takes on for the case of Volvo's Connected Car (see Figure 6).

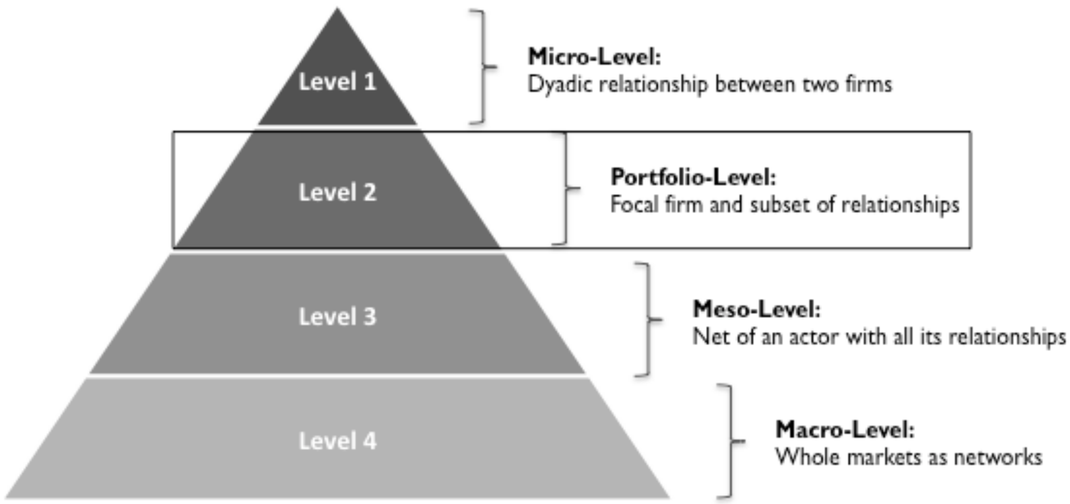

Figure 6: Relationship Level of Analysis (Mattson, 1997; Ford & McDowell, 1999; Möller & Halinen, 1999)

3.2.3 Open Innovation

Since IoT is a recent phenomenon, which drives industry convergence and leads to new settings and business opportunities, the involved actors need to adopt and innovate (Stieglitz, 2003). To capture the specifics of inter-organizational collaboration in innovation, this chapter introduces the research field of open innovation.

The basic idea of open innovation is that through the opening of the organization, knowledge of organizations can be combined, which enables above average innovative performance (Debackere et al., 2005; Tomlinson, 2010).

The term open innovation goes back to the revolutionary publications of Chesbrough (Chesbrough H. , 2003a; 2003b; 2003c), who was the first to define the research field.

Since the introduction of the term 'Open Innovation' by Chesbrough in 2003, research focused on different aspects and multiple definitions were used (Huizingh, 2011; Dahlander & Gann, 2010). In our paper we follow the definition of Chesbrough et. al (2006): Open innovation is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and to expand the markets for external use of innovation, respectively" (Chesbrough et al., 2006).

In contrast (see Figure 7), closed innovation assumes that successful innovation requires control. Companies must "generate their own ideas and then develop, build, market, distribute, service, finance, and support them on their own" (Chesbrough H. , 2004).

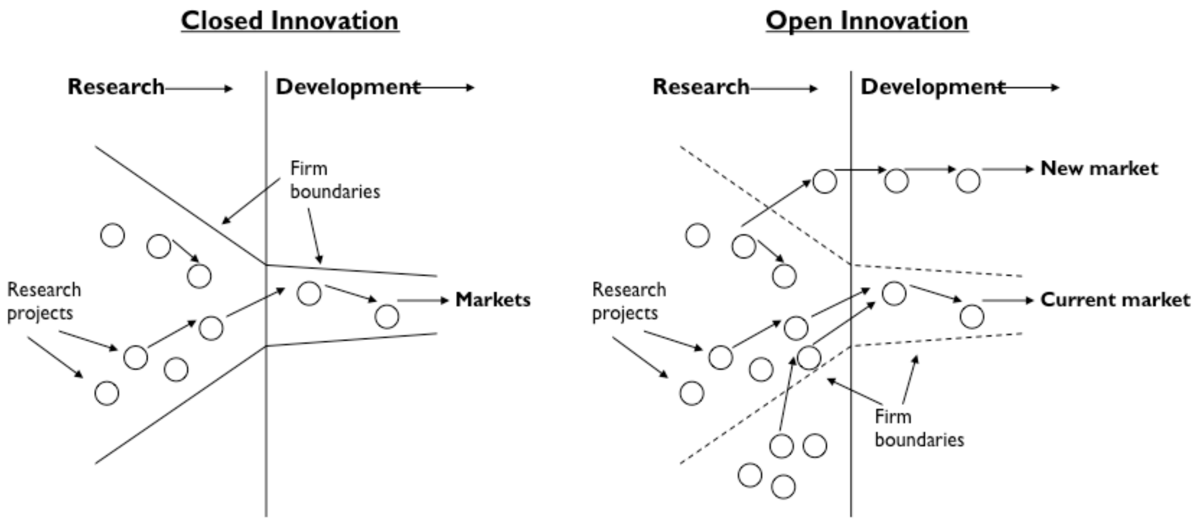

Figure 7: Closed vs. Open Innovation (Chesbrough, 2003c)

Open innovation encompasses inbound innovation (the internal use of external knowledge) and outbound innovation (the external exploitation of internal knowledge) (Huizingh, 2011) and can both focus on product and process innovation (West & Gallagher, 2006). This is in line with the three knowledge processes: Knowledge exploration, knowledge retention, and knowledge exploitation that can either be inside or outside the boundaries of a firm (Lichtenthaler & Lichtenthaler, 2009).

Research has found that open innovation and vertical cooperation has a positive impact on innovative performance, even though it is the strength of the ties and not just its existence that is important (Tomlinson, 2010). Laursen & Salter (2006) found a curvilinear relationship between open innovation and performance, which suggests that too much open innovation hurts performance. Other more soft benefits were outlined by Rigby & Zook (2002), which included an improved way of measuring the true value of innovation (e.g. benchmarking) and the ability to clarify the core competence of a company. Strategic benefits include enhancing the firm's technological position and getting access to new markets (Lichtenthaler, 2007; Nagaoka & Kwon, 2006). Limited knowledge is available about the cost of open innovation (Dahlander & Gann, 2010).

Several authors described the processes of open innovation (e.g. Gassmann & Enkel, 2004; Van de Vrande et al., 2009) and line-up best practices with case studies (e.g. Huston & Sakkab, 2006;

Dittrich & Duijsters, 2007). Other authors describe stages of open innovation processes (Fetterhoff & Voelkel, 2006; Wallin & von Krogh, 2010). Fetterhoff & Voelkel (2006) for instance outline five stages of the open innovation process (see Figure 8):

Figure 8: Stages of the Open Innovation Process (Fetterhoff & Voelkel, 2006)

Stage 1: The striving for unique technology solutions

Stage 2: The evaluation of utility and inventiveness of solutions

Stage 3: Recruitment of technology partners to enter business relationships

Stage 4: Monetization of utility and inventiveness in context specific customer needs

Stage 5: Identifying additional innovative products or extend existing technology to broader markets

An important issue of the open innovation process is how to capture value from the innovation. Dahlander & Gann (2010) point out that firms can use both formal methods (like copyright or patent protection) and informal methods (like first mover advantages and lock-ins) for value appropriation. Research illustrated that managing intellectual property (Strukova, 2009) and profit appropriation (Luoma et al., 2010) is very difficult when other actors are involved. This calls for clear and conscious strategies of the firms (Pisano, 2006; Henkel, 2006). Nevertheless, it was recently noted by Gassmann et al. (2010) that the internal management of open innovation is more trial and error than a professionally managed process.

3.3 Research Gap

IoT as part of digitalization inspires a wealth of new business opportunities, which ask for diverse partners and cross-industry ecosystems (El Sawy & Pereira, 2013; Burkhart et al., 2011). The new technology does not only challenge managers to adapt their businesses, but also calls for an academic research direction that combines the research fields of industry convergence, platform-centric networks and inter-organizational collaboration. In general, little research has been done at this intersection (see Figure 9):

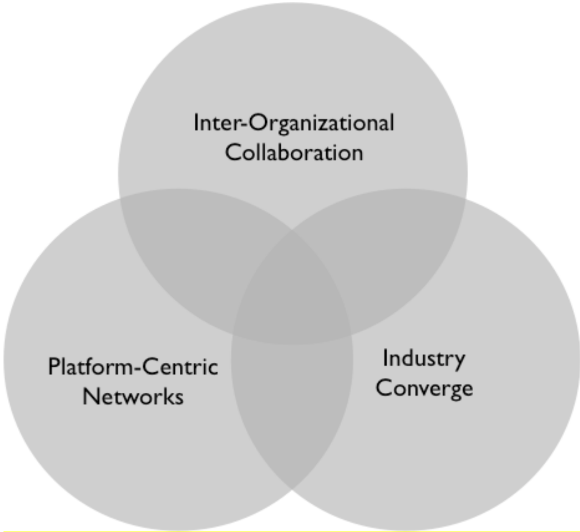

Figure 9: Research Field Intersection

Research about the collaboration on platform-centric networks in general has seen inflation in the past years (Cusumano & Gawer, 2002; 2008; Eisenmann et al., 2006; Gawner & Cusumano, 2002; Lehnherd & Meyer, 1997; Jiao et al., 2005; Enkel & Heil, 2014) but is often based within IT (Hedman & Kalling, 2003) or telecommunications (Tzeng et al., 2008). The specific managerial implications of IoT based platform-centric networks have been widely neglected so far.

Similarly, the IoT phenomenon gained increased popularity in recent years and has become a widely researched phenomenon (e.g Yoo et al., 2012; Mejtoft, 2011; Atzori et al., 2010). But the existing research has mainly been done from an engineering and data & computer science perspective (e.g. Atzori et al., 2010; He et al., 2014). Little research has been done about managerial implications from converging industries caused by the technological phenomenon IoT (Yoo et al., 2010; Yoo et al., 2012). As Yoo et al. (2010) point out, new research opportunities “are associated with new entrepreneurial opportunities that emerge from embedding digital capabilities into non-digital products and services” (p. 1), which require multi-disciplinary research from different domains.

Turber et al. (2014) are the first authors that combine the different research of platform-centric networks in an IoT environment. Their framework depicts value contributions of organizations on IoT platforms. According to the authors, platforms are created by the inter-organizational collaboration of complimentary actors. The framework spans a grid with three dimensions (‘Who’, ‘Where’, ‘Why’) to depict the value contributions of the actors within the platform. The pre-study identified that the framework is a static tool that is not sufficient in explaining how the involved actors interact. Therefore, a forth, dynamic process dimension is analyzed, which describes ‘How’ the involved actors collaborate. This is also in line with Yoo et al. (2010), who points out the need for future research in analyzing the “dynamics of innovation and the evolution of a focal firm and platform” (p. 26). Yoo et al. (2012) point out the need to examine the “new configurations of relationships among actors involved in innovation”, which is enabled by digital platforms (p. 1401).

Consequently, the study at hand builds upon the line of thought of Turber et al. (2014) and focuses on platform-centric network and inter-organizational collaboration literature, in order to fulfill its purpose of closing the research gap:

Lack of research on collaboration patterns on Internet of Things based platforms.

Addressing the exposed research gap, this study takes on an inter-organizational development view with its managerial consequences on collaboration in IoT based platform-centric networks and analyzes Volvo's Connected Car in detail to answer the main research question:

MRQ: What new collaboration patterns occur as a consequence of the introduction of new Internet of Things based technological platforms?

3.4 Theoretical Framework

The theoretical framework builds upon the three key aspects of collaboration patterns, which are derived from the pre-study and are enriched with relevant theory (see Figure 10). The described frameworks of general settings of collaboration (3.4.1), network positions and roles of actors (3.4.2) and uncertainties in the collaborations (3.4.3) build the foundation to answer the sub-research questions.

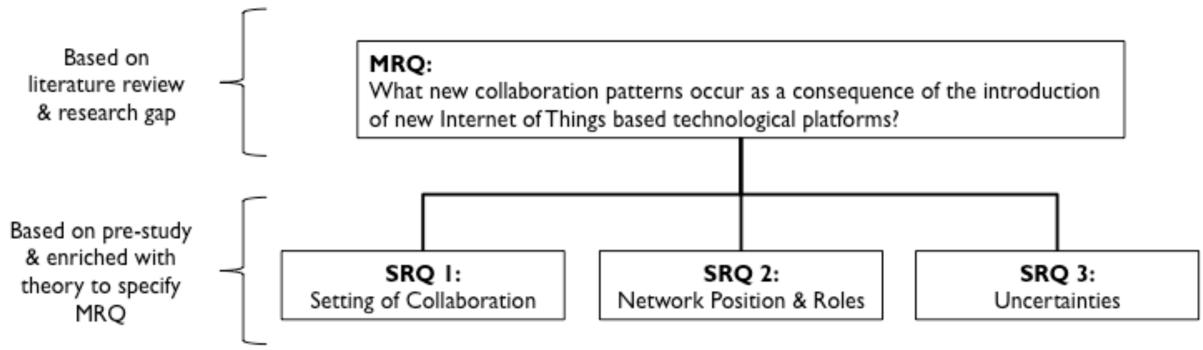

Figure 10: Structure of Research Questions

3.4.1 General Settings of Collaboration

General settings of collaboration were addressed to identify and describe collaboration patterns with the following sub-research question:

SRQ 1: How do actors within use cases define the general settings for collaboration?

The setting of collaboration is defined in this research as the governance of collaboration. Adopted from the corporate and public governance literature, governance of collaboration is defined as "ways in which co-ordination of inter-organizational collaboration is achieved and sustained" (Lowndes & Skelcher, 1998; Rhodes, 1997; Schleifer & Vishny, 1997). This could be for instance formalized coordination or communication processes or the legal framework. The sub-research question is approached in an explorative manner.

3.4.2 Network Positions and Roles of Actors

Network positions and roles of actors were addressed to identify and describe collaboration patterns with the following sub-research question:

SRQ 2: How does the focal actors' role and network position change between the use cases?

Network positions are defined as "the characteristics of the company's relationships and benefits, obligations, rights and privileges that derive from them" (Ford et al., 2002). Enkel & Heil (2014) add to the definition strategic network roles that impact the position of the focal actor in platform-centric networks. To answer the sub-research question, (1) network roles and (2) benefits and obligations of collaboration are analyzed.

Network Roles

The strategic network roles of Enkel & Heil (2014) outline the positioning of the focal actor in platform-centric networks. These network roles evolve with the deconstruction of traditional value chains. The provided differentiation is applied as the underlying framework (see Figure 11).

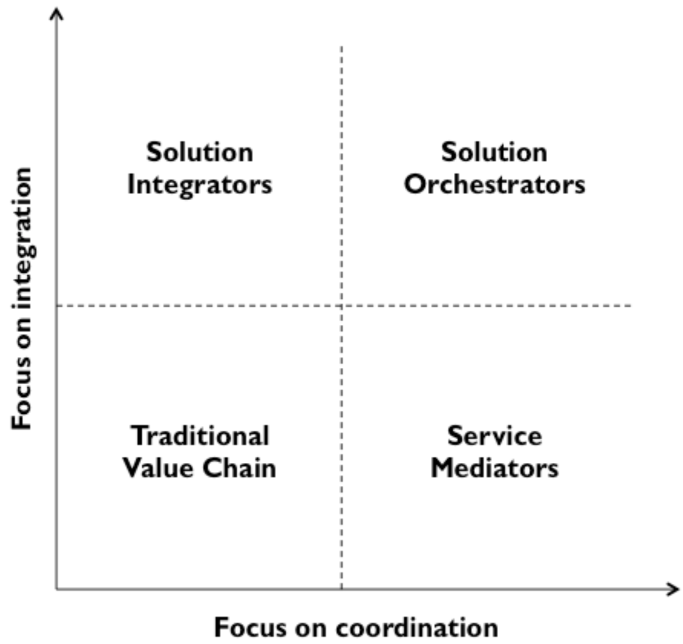

Figure 11: Strategic Network Roles (Enkel & Heil, 2014)

Three roles are differentiated:

- **Service mediators** focus on service coordination between actors and try to add new value creation steps into the existing value chain.
- **Solution integrators** try to complimentary enhance their own business models through cooperations, joint ventures and acquisitions.
- **Solution orchestrators** create an innovation ecosystem by integrating and combining complementary actors. Through their coordination efforts they facilitate competitive advantages for themselves and all involved actors.

Benefits and Obligations of Collaboration

Based on the network roles, the benefits and obligations are explored. Reviewing the inter-organizational collaboration and open innovation literature, the following benefits were prevalent:

- Monetary benefits (Rigby & Zook, 2002; Dahlander & Gann, 2010)
- Higher innovative performance (Debackere et al., 2005; Rigby & Zook, 2002; Dahlander & Gann, 2010)
- Access to resources, capabilities and knowledge (Sousa, 2014; Jacobides & Billinger, 2006; Dahlander & Gann, 2010)
- Improved way of measuring true value of innovation (Rigby & Zook, 2002)
- Ability to clarify core competence of a company (Rigby & Zook, 2002)
- Enhancing firm's technological position (Lichtenthaler, 2007; Nagaoka & Kwon, 2006)
- Getting access to new markets & ability to commercialize products (Lichtenthaler, 2007; Nagaoka & Kwon, 2006; Chesbrough & Rosenbloom, 2002)

The literature provides little insights about the obligations of collaboration. Therefore, obligations are approached in an explorative manner.

3.4.3 Uncertainties in the Collaborations

Uncertainties in the collaborations were addressed to identify and describe collaboration patterns with the following sub-research question:

SRQ 3: What are the main uncertainties within each use case and how do the actors handle those?

In this research, uncertainties are defined as a situation "where the current state of knowledge is such that (1) the order or nature of things is unknown, (2) the consequences, extent, or magnitude of circumstances, conditions, or events is unpredictable, and (3) credible probabilities to possible outcomes cannot be assigned" (Holosko & Thyer, 2011).

The applied framework stems from Ford et al. (2002). The authors differentiate between customers and suppliers in a B2B relationship that face different uncertainties:

Customer uncertainties:

- **Need uncertainty:** Uncertainty about clear problem definition and whether solution will solve the problem.
- **Market uncertainty:** Uncertainty about which solution to choose for a given problem.
- **Transaction uncertainty**: Uncertainty whether supplier will fulfill the promised offering.

Supplier uncertainties:

- **Capacity uncertainty:** Uncertainty about amount of offerings that are likely to sell.
- **Application uncertainty:** Uncertainty about the way offerings can most effectively be used by customers.
- **Transaction uncertainty:** Uncertainty whether customer will actually take deliveries and will pay in time.

Answering the sub-research questions promises a differentiated, in-depth view on the collaboration of actors engaging in collective innovative activity. By looking at the collaboration, interactions between the actors are examined that explain 'How' they collaborate, enabling the identification and description of IoT specific collaboration patterns in a platform-centric network.

Themes	**Approach**	**Applied Theories**
General Settings of Collaboration	Exploratory	
Network Positions:		
Network Roles	Theoretical	Enkel & Heil (2014)
Benefits	Theoretical	i. a. Rigby & Zook (2002); Dahlander & Gann (2010)
Obligations	Exploratory	
Uncertainties	Theoretical	Ford et al. (2002)

Table 1: Themes and Approaches

Table 1 summarizes the theoretical framework and categorizes the approaches of the different cluster. The theory of this chapter is used to guide interviews and subsequent coding. The interview guideline is structured according to the three sub-research questions and relevant theory of the theoretical framework (see Appendix 4).

The theory will also support the analysis in chapter 6. The level of departure for the analysis is the organizational level, where collaboration between organizations as a whole is analyzed (Gemünden & Ritter, 2003). Within the networks of the use cases a portfolio-level is chosen, where the focal firm is taken as a starting point (in this case Volvo) and then the subset of relationships is analyzed (Ford & McDowell, 1999).

4 Methodology

This chapter presents the methods used for conducting the research and motivates the methodological decisions by emphasizing logical reasoning and methodic fit behind the methods chosen. All methodological choices were made to minimize consequences from limitations and constraints while ensuring validity, reliability and objectivity. First, the research strategy is outlined (4.1). Second, the research design (4.2) is shown by explaining methodological fit (4.2.1), case selection (4.2.2), data collection (4.2.3) and analysis for both pre- and main-study (4.2.4). Last, this chapter covers reliability, objectivity & validity (4.3) as well as methodological limitations (4.4).

4.1 Research Strategy

This study takes on the widespread position of neurobiological constructivism on social processes (Roth, 1996), admitting the pre-existence of the research objects before observation.

While a positivistic stance on research is more suitable for natural science research objects, in social science, the hermeneutic view on research prevails (Bryman, 2012). This study seeks to understand as opposed to explain and takes the specific point of view from the different people involved into account. Therefore, a hermeneutical-phenomenological stance towards conducting research is appropriate (Bryman, 2012).

As with other topics of research strategy, the lines between qualitative and quantitative research are fluid (Creswell, 2009). Given the hermeneutical-phenomenological approach and the nascent state of the research area, an explorative approach to research strategy is appropriate (Silverman, 2013). Exploration is often hard to operationalize and quantify, especially when lacking available benchmarking data. For these reasons this study was conducted by using a qualitative research strategy, mainly by applying the semi-structured interview method within a single embedded case study (Yin, 2014). This study follows the standards and quality criteria of qualitative social research.

4.2 Research Design

This section explains the methodological fit of the research purpose with the study methodology, motivates the case selection and explains the methods applied to collect and analyze relevant data.

4.2.1 Methodological Fit

The novelty of the IoT phenomenon classifies this research field as nascent (Edmondson & McManus, 2007, p. 1158). With little existing academic literature about IoT platforms in management, the research field favors an explorative search strategy to identify interesting research areas. Therefore, a narrative review approach of existing literature was applied to determine the current state of scientific research within this field (Bryman, 2012, p. 110-113).

In order to identify and describe collaboration patterns on platform-centric networks within the IoT context, an exploratory approach (Creswell, 2009) was chosen. The explorative stage was used to develop the research question of this study. In parallel relevant theory was searched for, identified and prepared to investigate the research question. After thoroughly analyzing possible research subjects, the case selection was made.

With IoT and collaboration on platforms as the starting point, a meticulous literature analysis was conducted, incorporating academic search tools (JSTOR, EBSCO, Google Scholar) using key terms to find additional relevant source (Bryman, 2012, p. 119). Fitting sources were further examined and quotation patterns identified and acted upon. Through this snowball strategy approach a database containing the relevant works was constructed (Creswell, 2009). The existing literature then was used to set the research focus and limit the scope of the study. In addition, press releases from major actors within the automotive IoT sector were gathered to build preliminary clusters as a basis for further investigation.

The purpose of this study is to answer the main research question:

MRQ: What new collaboration patterns occur as a consequence of the introduction of new Internet of Things based technological platforms?

In order to examine the emergent phenomenon of IoT platforms within the automotive industry, the qualitative case study method was applied as it is deemed appropriate for research objects within real life contexts (Yin, 2014). This study focuses on a single case study approach that allows exploring one case in depth and increases effectiveness by setting effective boundaries to the research conducted (Yin, 2014). The rationale for choosing the case is the unusual combination (Yin, 2014, p. 51-52) of the Internet of Things and Volvo's Connected Car.

The focus on a single case combined with the qualitative approach to research favors a two-step research design, with a pre- and main-study, allowing detailed analysis of the case (Bryman, 2012).

The objective of the pre-study was to identify all relevant actors around the researched case and derive findings to define precise in depth sub-research questions for the main study.

The main-study was based on insights from the pre-study, enriched with relevant theory within the fields of industry convergence, inter-organizational collaboration and platform-centric networks to identify and describe collaboration patterns.

4.2.2 Case Selection

Multiple factors were considered before the case selection was made. This section motivates the specific case chosen in regard to industry (automotive), phenomenon (Internet of Things), platform (Volvo's Connected Car) and observation object (collaboration of actors).

Industry: Automotive

Two main factors sparked our research interest in this particular industry:

One, the industry structure has become extremely complex with many actors involved. With increased importance of IT solutions within the offerings of automotive OEMs, the traditional automotive industry is forced to collaborate with actors of different sizes from other industries such as IT or telecommunication. The resulting convergence of industries leads to a dense network of supplier and partner relations between different actors.

The current changes in the industry leads to high attention from the media (see Figure 12). With very big companies newly entering the industry (Tesla, Google, Apple), visibility of the automotive industry increases and the structural shifts within the industry become more and more apparent.

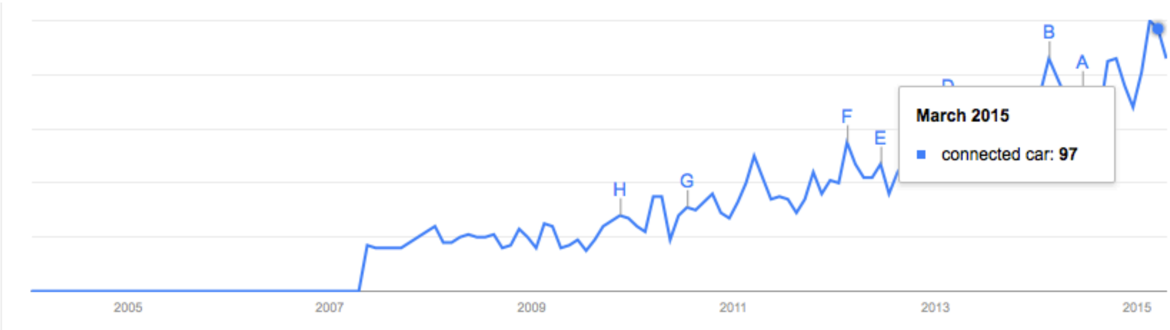

Figure 12: Google Trends – Connected Car 2005-2015 (accessed April 11th 2015)

Two, our literature review revealed a research gap about collaboration on IoT based technological platforms. The field, even though highly newsworthy, does not get much attention from academia and therefore is under-researched. Existing studies on collaboration on IoT platforms exist within the area of smart homes (Turber et al, 2014). Other studies are not paying attention to the IoT phenomenon, focusing only on collaboration e.g. within IT (Hedman & Kalling, 2003) or telecommunications (Tzeng, Chen, & Pai, 2008).

Phenomenon: Internet of Things

As is the case for the automotive industry, Internet of Things as an emerging phenomenon gained increasing attention (see Figure 13) when more and more big actors decided to invest into IoT related projects, e.g. IBM (IBM, 2015) or Cisco (Cisco, 2014).

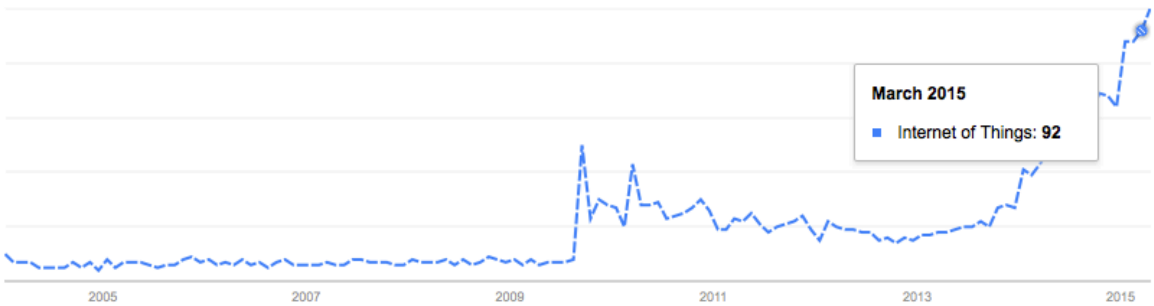

Figure 13: Google Trends – Internet of Things 2005-2015 (accessed April 12th 2015)

Ericsson forecasts that by 2020 there will be 50 billion connected devices (Ericsson, 2010). The connection of vehicles advances at a rapid pace:

"The connected car is already the third fastest growing technological device after phones and tablets." (BBC News, 2013)

The anticipated changes that the IoT phenomenon will cause are enormous and are deemed revolutionary, therefore making it an interesting research field to dive into early on.

Platform: Volvo's Connected Car

Our analysis of connected car projects showed that every big automotive OEM possesses a connected car initiative of some sort. In addition to the traditional OEMs, many tier one supplier (e.g. Continental) and multinational service and product provider (e.g. Google, Apple) are involved in a connected car initiative. We chose Volvo's Connected Car platform with the Volvo Sensus Connect and Volvo On Call Service bundles for two main reasons:

Through network analysis, we identified key actors within different connected car initiatives. The connected car initiative around Volvo became visible very fast, showing Volvo as the central player with strong appearance of Ericsson as a partner as well. This meant two key actors within the connected car initiative were both located in Sweden in close proximity to each other and the researchers of this study. Close proximity in multiple dimensions fosters collaboration by facilitating social and cultural understanding, institutional, organizational and geographical accessibility and ease of technological integration (Knoben & Oerlemans, 2006). High visibility of two key actors within the connected car initiative gave easy access to start exploratory research and to unfold the whole actor network.

Both key actors are Swedish companies and therefore act within the Swedish cultural and regulatory environment. Characteristics of the Swedish cultural and regulatory environment are the easy accessibility of key person within an organization, an open and helpful mentality towards research projects, transparence through regulations and laws, mandating to disclose a high degree of information compared to other countries.

Observation Object: Use Case Dependent Collaboration of Actors

Looking at the involved actors in Volvo's Connected Car platform by taking the theoretical framework of Turber et al. (2014) as a structuring device, showed interesting constellations of involved actors and revealed key aspects about the process dimension of collaboration. The pre-study indicated use case specific collaboration patterns, which were evaluated as promising for further research in the main study. Many of the involved actors come from different industry backgrounds and vary in company size and age. These differences promised interesting research insights, 'waiting to be discovered'.

4.2.3 Data Collection

The main source of data collection was through two rounds of semi-structured interviews with different actors, mainly conducted over phone, Skype or face-to-face, depending on geographical proximity and availability. Those sources were enriched with industry reports, company documents, such as press releases and academic articles to attain a holistic view of the case and maintain high integrity of the study (Silverman, 2013).

The semi-structured interviews were setup according to standard procedure for qualitative research (Mayer, 2009). For pre- and main-study an interview guideline containing clustered questions to relevant topics was constructed (see Appendix 2 & 3). Open questions were used to engage the interviewee and foster a stringent narrative throughout the whole interview (Bryman, 2012).

During all interviews both researchers were present, allowing the multi observation method with an interviewer actively managing the conversation, while the observer took notes and paid attention to language details like tone of voice, mood and comfort of the interviewee (Mayer, 2009). All interviews were recorded and then transcribed (Bryman, 2012), adding additional observation mediums. Always after the interviews a short discussion between the researchers was held, impressions about the conversation exchanged and notes completed. To ensure context accuracy (Bryman, 2012), the transcription of the interviews was carried out within the next day of an interview. Additional interviews were scheduled until empirical saturation to answer the research question was reached. The specific interview guidelines and the data analysis differed slightly between pre- & main-study.

The pre-study was of exploratory nature and used the framework of Turber et al. (2014) as a structuring device. The goal was to identify involved actors of Volvo's Connected Car and key aspects of collaboration patterns. Mapping the new actors and adding new insights gained from the interviews on a continuous basis allowed to steer the upcoming interviews in a fruitful direction, leading to more focused conversation about researching relevant information. The continuous mapping was accompanied by reviewing industry reports and company information to verify and triangulate statements made during the interviews.

The main study was based on the findings derived from the pre-study. During identification of actors and key aspects for collaboration patterns, insights were gained on which the main study was build upon. The pre-study indicated use case specific collaboration between the involved actors on the platform of the connected car.

This finding was in line with industry reports about the classification of connected car use cases into three categories: Car & platform-centric, driver-centric and environment-centric view (Arthur D. Little, 2014; Telefonica, 2014; Ericsson, 2014; AutoScout24, 2014; GSMA, 2013). One ideal type was chosen for every use case category of the connected car to depict the variety of collaboration processes, compare the use cases and derive differences between them (see chapter 6.2). The main study therefore focused on the use case specific collaboration of actors on the connected car platform and analyzes one use case per connected car category.

Three sub-research questions were defined and set as main study research goal:

SRQ 1: How do actors within use cases define the general settings for collaboration?

SRQ 2: How does the focal actors' network position and role change between the use cases?

SRQ 3: What are the main uncertainties within each use case and how do the actors handle those?

Fore specific information about how those sub-research questions were derived, see chapter 2.

The interview guideline for the main study contains four question clusters, one cluster containing general questions and three containing questions related to the sub-research questions. For the detailed semi-structured interview guideline of the main study, please see appendix 3. The sample for the main study includes participants from nine different companies (Bring, Cybercom Group, Linas Matkasse, Mitsubishi Electric, Telenor, Telenor Connexion, Trafikverket, Volvo, WirelessCar), working on different strategic levels (e.g. Co-Founder, Director, Managing Director, Solution Manager, Account Manager, Senior Vice President, Project Manager) and within different functions (Business Development, General Management, Logistics, Sales, Strategic Management and R&D).

4.2.4 Data Analysis

The data analyses conducted for both pre- and main-study are based on Mühlfeld's six-step method (Mühlfeld, 1981). See Figure 14 for an overview:

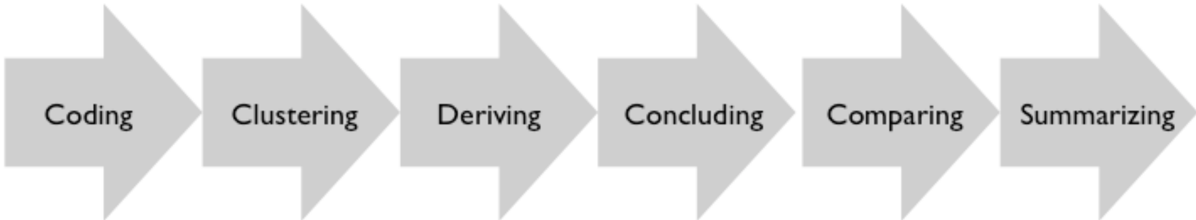

Figure 14: Six Step Approach to Qualitative Data Analysis (according to Mühlfeld, 1981)

First, all transcripts and notes were coded that gave an answer on questions asked in the interview guideline. Second, the answers were matched with the theoretical framework and prior findings and answer clusters were built. Third, the isolated information in form of statements was sorted to derive the core statement. Forth, a small conclusion was written for every cluster, explaining the core statement. Fifth, the conclusions were compared with the transcribed interview passages and observation notes and changes were made if necessary. Finally, the gained insights were summarized in form of a report.

For the analysis of the pre-study, a total of 240 interview minutes were transcribed, resulting in 45 pages of transcripts and notes, containing 27'325 words. During the main study, interviews of 500min in total length were conducted, yielding a research material volume, including transcripts and notes, of 87 pages, containing 57'307 words. In total, primary data amounting 740min of interviews leading to 132 pages of transcripts with 84'632 words were produced and processed.

4.3 Reliability, Objectivity & Validity

As in quantitative research, ensuring high quality is essential, but the way reliability, objectivity and validity is applied differs between those research designs (Bryman, 2012).

4.3.1 Reliability & Objectivity

Reliability is the precision of measurements meaning if the measurement is conducted multiple times, the same result should emerge. Replicability therefore is a logical consequence of high reliability. Both factors together are important indicators for the quality and objectivity of research (Trochim & Donnelly, 2008).

Objectivity refers to the independence of measurement and results from the persons that conduct the research. Since qualitative studies are interpreted by the researchers and not operationalized with numeric constructs, a major threat to objectivity is the researchers interpretation of the collected data (Silverman, 2013). The derived findings might not be the same if others analyzed the data.

While it is impossible to completely eliminate personal interpretation, spreading the analysis work between both researchers increased objectivity in this study. In addition, the division during data collection, observing and interviewing further helped to have separate positions. The person that did not conduct the interview was always doing the transcription in order to take a neutral stance towards what was being said (Bryman, 2012). By strictly adhering to the analysis method (six-step approach according to Mühlfeld, 1981), the risk could be minimized further. The collected data was coded separately and then consolidated. In step five the comparison took place individually again to increase objectivity and therefore increase reliability.

4.3.2 Validity

Validity refers to how accurate the research method chosen measures the research object and can be split into three sub categories: Construct validity, internal validity and external validity. Internal validity in this case can be neglected since the case study is exploratory in nature (Yin, 2014, p. 46). External validity, referring to the generalization, does not have high relevance either, because the findings suit a very specific field and stem from exploratory research in a nascent research field focusing on a single case study and therefore do not claim to be universal. The category with the highest importance is construct validity that refers to how well the measurement is constructed to operationalize the research subject (Silverman, 2013). Construct validity is especially challenging for case study research (Yin, 2014). Through the application of Turber et al. (2014) as a structuring device for the pre-study interview guideline, a theoretical basis was chosen to start the study. Then the construct itself was examined in detail, resulting in focus change from the initial static model to a dynamic explorative approach. The construct for the main study is based on empirical findings from the pre-study and enriched by relevant theories and other sources of evidence, generating a chain of evidence to increase construct validity (Yin, 2014, p. 47).

4.4 Limitations

No matter which research method is chosen, there are always limitations coming along when conducting a study, even though theoretical recommendations and benchmarking was taken into account. Three case specific limitations to the presented research design are described and elaborated.

4.4.1 Confidentiality and Data Bias

The research method of collecting information by conducting semi-structured interviews inherits the risk of retained information. Since the research topic on IoT and connected car is very present within the media, it is possible that some interview participants withheld information due to confidentiality reasons or to reduce the risk of exposure. Using interviews as main source of gathering information usually leads to a slightly too positive view on the research subject because the interviewees want to convey a positive image of their own situation and the situation their organization is in (Bryman, 2012). Interviewing multiple persons within one organization independent of each other allowed getting two viewpoints on the same actor, therefore reducing the impact of the individual data point.

4.4.2 Research in Non-Native Tongue

Most sources, primary and secondary, were acquired or processed in non-native tongue for the researchers (English). The interviews were also mainly held in English, not being the native language for both parties involved. These circumstances can lead to misunderstandings due to different linguistical and cultural perceptions and understandings (Bryman, 2012). Having two researchers present at every interview helped to reduce possible misunderstandings. The transcription and individual coding of the collected material further helped to reduce negative impact on research outcome.

4.4.3 Stakeholder Abundance

Due to the many stakeholders involved in and around Volvo's Connected Car platform, it was not possible to obtain in-depth information about all stakeholders. This study acts on a meso-level, incorporating the different actors involved in the use cases but only to the degree that they are relevant to describe the actor network and the collaboration patterns on the IoT platform. The focus lies on the focal actor and the surrounding network and ends with the first tier stakeholder surrounding the focal actor.

Handling these limitation allow to precisely answer the research question asked.

5 Empirical Findings

Our explorative study examining Volvo's Connected Car started out with the pre-study, identifying the actors involved in Volvo's Connected Car platform and characterizing them in the actor network (5.1). Then the main study was constructed based upon the primary findings of the pre-study: Use case dependent collaboration (5.2), focusing on three key aspects of collaboration (collaboration setting, network position & role and uncertainties). These key aspects were investigated in detail in three distinct use cases, one for each connected car perspective: Car & platform-centric (5.3), driver-centric (5.4) and environment-centric (5.5).

5.1 Actor Network

Through the study, the actor network was constructed (Figure 15). Volvo emerges as the focal player of the connected car network, cooperating directly with all other actors involved.

Figure 15: Volvo's Connected Car Actor Network

This network is further enriched with specialized information of the actors. Table 2 briefly describes the most important actors that were part of the study and their involvement in the connected car platform. Understanding the actors is the basis for the following chapters describing the empirical findings of the use cases (see chapter 5.2 – 5.5).

Actor & Industry	Description
Automotive (OEM)	Volvo is the focal actor within the connected car platform. For simplicity reasons, this study considers the Volvo OEM and the Volvo dealers as one unit (Volvo).
Telecommunication	For Volvo's Connected Car, Ericsson is providing the Service Enablement Platform and acts as a cloud service provider in the car & platform-centric use case.
Automotive (Telematics)	WirelessCar is the provider of the basic telematics solutions in the Volvo cars and actively participates in the car & platform-centric use case. The company originates from a joint venture between Ericsson, Telia Sonera and Volvo in 2000 (Interviewee[09], 2015)
Automotive (Supplier)	Mitsubishi Electric supplies electronic parts within the car & platform-centric use case as a device provider.
Public Sector (Road Authority)	In the environment-centric use case, Trafikverket is a pilot partner and acts as a data customer (Interviewee[13], 2015).
IT (Connectivity Solutions)	Within the car & platform-centric use case, Cybercom Group is creating applications and sells know-how to project partners.
E-Commerce (Groceries)	Linas Matkasse acts as a pilot partner in the driver-centric use case by providing ready to cook groceries on a subscription basis directly to the customers' cars. The kind of menus, frequency and the volume depends on the kind of subscription bought (Linas Matkasse, 2015).
Logistics	Bring is acting as the logistic partner in the driver-centric use case.
Telecommunication (Network Provider)	Telenor is the network provider for the platform around Volvo's Connected Car.
Telecommunication (Services)	Belonging to Telenor Digital within the Telenor Group, Telenor Connexion is providing information & communication services with focus on connectivity. They provide IT consulting services within the car & platform-centric use case.

(Data Provider – Navigation)	Nokia HERE is representative for content provider in general and acts as the map data provider in the car & platform-centric use case.

Table 2: Volvo's Connected Car Actor Descriptions

5.2 Use Case Overview

By looking at the short descriptions of the main actors involved in the connected car, the variety of companies engaging in collaboration becomes visible. The main finding from the pre-study was that the collaboration must be differentiated between separate use cases (see chapter 2). With high empirical saturation the participants in the pre-study pointed out the need to distinguish between different use cases to evaluate and describe who is involved in the connected car platform and how the involved players act together.

Figure 16: Connected Car Perspectives (Arthur D. Little, 2014)

By looking at relevant industry and trend reports (Telefonica, 2014; TNS, 2014; Arthur D. Little, 2014; Ericsson, 2014; AutoScout24, 2014; GSMA, 2013), three views on the connected car emerge, that put a different perspective in the middle of the connected car (see Figure 16). Those views also emerged in the pre-study:

"[The] connected car alone is worthless. No one pays for the connected car. People only pay for use cases. That means for tangible customer value. The question is who is willing to pay? […] One answer is the customer, when he can bring his digital world with him into the car. The second topic is invisible services, meaning things that improve the car. And the third revenue case is to arrange traffic more efficiently." (Interviewee[03], 2015)

By applying those three views, all use cases can be categorized depending on the perspective on the connected car. Those perspectives are:

- **Car & Platform-Centric:** Focusing on the car itself or the build-up of the platform within the car that acts as a central node and gateway between the different components. Examples are the Volvo service Connected Service Booking that helps to pro-actively service Volvo cars or the Sensus Connect Infotainment System that allows connectivity and links to multiple services and systems inside and outside the car.

- **Driver-Centric:** Looking at the connected car through the drivers' eyes. This perspective describes services that directly enhance the driver experience or create value for the driver. For example Roam Delivery, where parcels get delivered without the owner's involvement directly to the car or reservation and booking of parking spaces.
- **Environment-Centric:** Connecting the car to the surroundings by enabling data sharing in close proximity with other vehicles or by aggregating data in the cloud to enable services to a broad audience. For example the Road Friction Project were road friction data is gathered and aggregated to improve road maintenance and safety or POC bicycle safety were bicycle helmets communicate with cars surrounding the biker, warning them if they are on collision course.

To identify and describe collaboration patterns, the process dimension of collaboration between actors must be examined. Therefore the use case specific collaboration was investigated further during the main study, including the most visible case with the most accessibility of each perspective:

- **Car & Platform-Centric:** Volvo Onboard Connect Infotainment System
- **Driver-Centric:** Roam Delivery Project
- **Environment-Centric:** Road Friction Project

In chapters 5.3-5.5, the three use cases are explained in detail in order to give context for further analysis in chapter 6. The structure follows the logic of the sub-research questions. First the general settings of collaboration are described; second the network positions and roles of actors are shown, including benefits and obligations and third, uncertainties in the collaboration are depicted. Only actors with active participation are included in the use case description to maintain focus on the collaboration.

5.3 Car & Platform-Centric: Infotainment

Volvo's onboard infotainment system keeps the car connected and enables multiple functions in and around the car: Entertain, connect, navigate & services (Volvo Cars, 2015). The functionalities entertain, connect and navigate are summed up as the Sensus Connect system (Volvo Cars, 2015). The functionality services includes telematics, allowing to remotely heat, start, lock or locate the car, and emergency communication or road side support, summed up as the On Call system (Volvo Cars, 2015). In this use case the difference is made between the Volvo Sensus Connect and the Volvo On Call system due to different origins and companies involved in the build-up process of those two systems (Interviewee[09, 02], 2015).

Both systems are heavily intertwined and may look like one offering towards the consumer (Interviewee[02], 2015) but possess different back-ends and different connection lines from a technical point of view (Interviewee[09], 2015). Together, these systems enable the general connectivity of the Volvo cars and allow the interactions with the driver, other cars, the manufacturer, the environment and other potential actors. Both systems together constitute the basis of the platform on which all other use cases are built upon. Figure 17 shows the actor network of the infotainment use case.

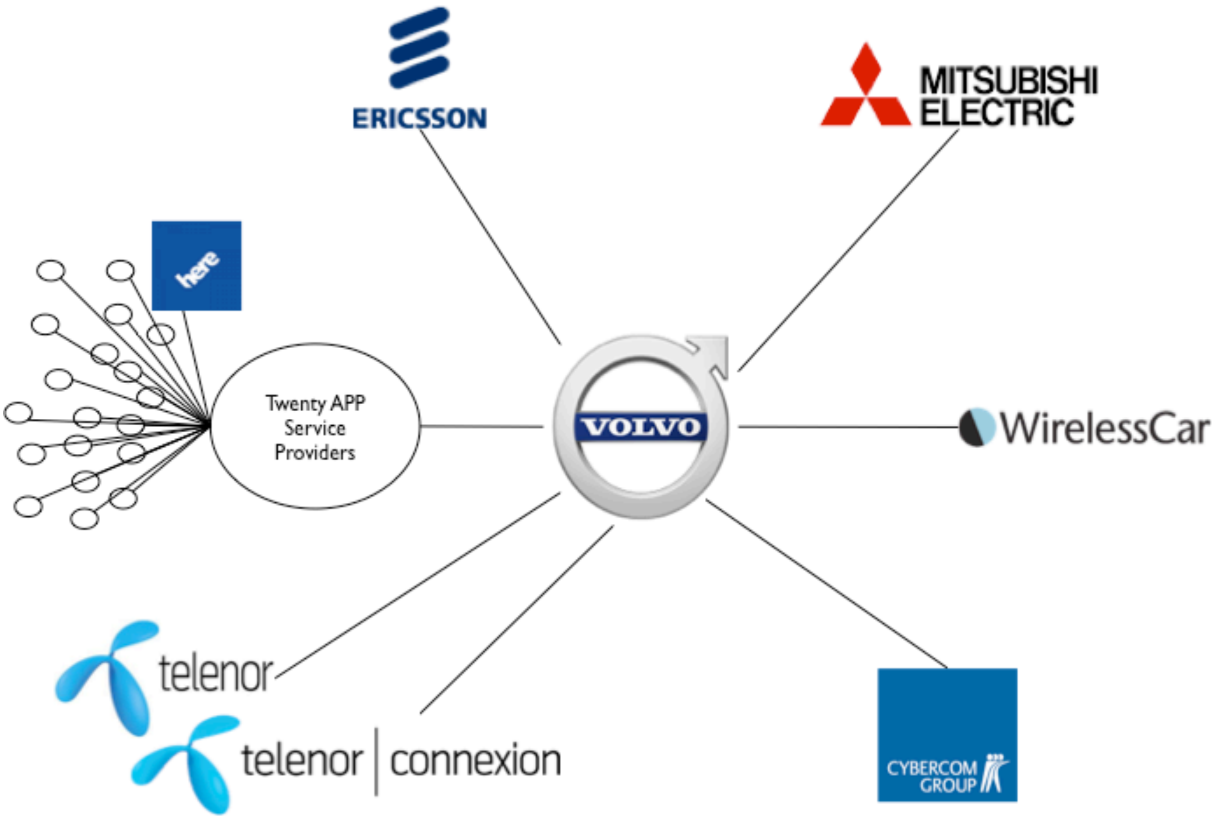

Figure 17: Car & Platform-Centric Actor Network

5.3.1 General Settings of Collaboration

Volvo is the focal actor in the middle of the network, orchestrating all the partner relationships around to provide the best possible service for its customers. The infotainment system belongs to Volvo's core business. Every new Volvo car will have the newest version of those systems implemented. Over 10 billion USD have been invested throughout the whole development cycle at Volvo (Interviewee[07], 2015). With these big investment volumes come strict procedures and formalized processes to steer the research and development (Interviewee[07], 2015).

"We have extremely strict project definitions and project timelines and organizations for a project likes this. […] It gets extremely expensive, extremely quickly. That's why we have to be very strict." (Interviewee[07], 2015)

The basic collaboration setup represents a common automotive supplier customer relationship between the OEM and his tier one suppliers (Interviewee[07], 2015): Requirements and specifications are made by the OEM and then handed down to the supplier. When those specifications are met and all requirements are fulfilled, exact contracts are negotiated and prices and volumes are set in fixed contracts.

The traditional setup is applied for all relationships within the infotainment system except for content provider such as TuneIn or Storyteller. They need different setups mainly due to their size (Interviewee[07], 2015). The setup is also different since they deliver a branded service, which is contrary to the commodities of normal automotive suppliers (Interviewee[14, 15], 2015).

"If you are going to deliver to Volvo then we expect you to take warrant obligations and to have people available at the factory and things like that. And obliviously that's not something we can require of lets say Storyteller, a small company with 15 people." **(Interviewee[07], 2015)**

To solve technical problems, suppliers often collaborate among themselves to overcome occurring problems (Interviewee[14, 15], 2015). This lateral collaboration is usually ad-hoc and issue based and not secured by any contracts except for standard NDAs (non-disclosure agreements). Suppliers try to solve arising conflicts themselves by negotiating carefully or rely on Volvo as an intermediary to solve the conflict for them (Interviewee[14], 2015).

5.3.2 Network Positions and Roles of Actors

There are eight actors involved in the infotainment use case (see Figure 17): Cybercom Group, Ericsson, Mitsubishi Electric, Nokia HERE, Telenor Connexion, Telenor Sweden, Volvo and WirelessCar.

Role of Actors

Volvo takes on the role as the focal actor, coordinating all other actors with specific fields of know-how and responsibility and is the only actor with end-customer contact except for network provider (Telenor Sweden) and content provider e.g. Nokia HERE (Interviewee[07, 09], 2015):

- **Cybercom Group:** IT service provider (Interviewee[19], 2015)
- **Ericsson:** Cloud service provider by offering the Service Enablement Platform (Interviewee[06], 2015)
- **Mitsubishi Electrics:** Device provider supplying head-unit, amplifier, display, digital tuners (Interviewee[14], 2015)
- **Nokia HERE:** Providing map data for the Sensus Connect navigation (Interviewee[12], 2015)
- **Telenor Connexion:** Providing connectivity for the On Call system (Interviewee[21], 2015)
- **Telenor Sweden:** Providing connectivity in Sweden for the Sensus Connect system (Interviewee[20], 2015)
- **WirelessCar:** Telematics provider (Interviewee[09], 2015)

Benefits & Obligations of Actors

All involved actors are participating for monetary reasons, given the size of investments, the amount of actors and number of customers involved (Interviewee[07, 09, 12, 15], 2015).

Non-monetary reasons are expertise, experience and know-how (Interviewee[07], 2015).

"Of course we are gaining some experiences and knowledge always when we have these type of cooperation when we have something like this, like how you call it, more soft type of benefits."
(Interviewee[15], 2015)

Depending on the kind of deliverable towards Volvo, the obligations between the involved actors change. All deliverables are either providing human resources (consulting services and specialist work-hours) or delivering products and services. The products are dividable into tangible and intangible (data or software) products.

- **Volvo:** Commits to prices and volumes (e.g. one million units over the life-cycle of a car) or buys services case-based or time-based and is obligated to remunerate the deliverables (Interviewee[07], 2015).
- **Cybercom Group**: Software products and human resources (Interviewee[19], 2015)
- **Ericsson:** Software services (Interviewee[06], 2015)
- **Mitsubishi Electrics:** Tangible products (Interviewee[15], 2015)
- **Nokia HERE:** Software products (Interviewee[12], 2015).
- **Telenor Connexion:** Connectivity service and human resources (Interviewee[21], 2015)
- **Telenor Sweden:** Connectivity service and human resources (Interviewee[20], 2015)
- **WirelessCar:** Software services (Interviewee[09], 2015)

5.3.3 Uncertainties in the Collaboration

Four major uncertainties were identified from all the material collected:

- **Uncertain market needs:** The difficulty to anticipate market trends and future development in the area of connected vehicles (Interviewee[07, 09, 12], 2015).
- **Technical complexity, security, integrity & quality:** The complexity of the car is seen as unique, compared to other industry products (e.g. mobile phones or consumer electronics). The technical challenges paired with need for security of vehicles and data and integrity of generated and distributed information are not solvable with a fixed recipe (Interviewee[09, 15], 2015).

"The complexity of the car can't be compared with any other product on the market."
(Interviewee[09], 2015)

- **Business case uncertainty:** The technical possibilities exist to create offerings with connected vehicles. Consumers are ready to use those offerings but often not ready to pay for them. How to monetize the connectivity is uncertain (Interviewee[07, 09], 2015).
- **Uncertainty about being replaced in the long term:** The low operating margins in the automotive sector require precise cost control (Interviewee[15], 2015). Therefore, all replaceable supplier relations are evaluated after one development cycle of a car, usually after three to five years (Interviewee[14, 15]).

Five ways to reduce and handle the use case specific uncertainties were mentioned frequently:

- **Benchmarking in car and other industries:** Comparing with other industry players and looking at other industries for transferable solutions to solve its own problems (Interviewee[07, 17, 18], 2015).
- **Adapt organizational setup to handle uncertainties**: Constantly adapting and shifting the organizational structure and setup to be able to better cope with the uncertainties (e.g. building cross-functional teams or flattening the hierarchy) (Interviewee[07, 09, 18], 2015).
- **Follow the vision of your customer**: Aligning your offerings with the vision of your customer to provide accurately fitting solutions that cannot be bought easily elsewhere (Interviewee[10, 15], 2015).
- **Close collaboration and interchange to reduce and handle uncertainties:** Communicate often and closely with many different actors involved to avoid redundancies and to stay update about the latest developments and insights that could help to cope with uncertainties (Interviewee[07, 09, 10, 14], 2015).

"We try to over-communicate. So basically we talk to each other and complain to each other every day." (Interviewee[14], 2015)

- **Uncertainties cannot be reduced completely and need to be dealt with:** In the end, uncertainties can never be eliminated completely. Therefore seeing and accepting them as given helps to handle them objectively and strategically (Interviewee[07], 2015).

5.4 Driver-Centric: Roam Delivery

With the connectivity enabled through the infotainment system (see chapter 5.3), many possibilities emerge to connect people and machines. One project in this area is roam delivery, where items get delivered directly into the owners' cars, without the car owner's involvement.

Volvo conducted a pilot project together with Linas Matkasse to test this use case (Savov, 2014). During a three-month period, Linas Matkasse delivered grocery bags directly to Volvo employees' cars at Volvo Car Group headquarters in Torslanda, Gothenburg (Interviewee[08], 2015). A special application was created that allowed the delivery personal from Bring to search for the car, open the booth, put the grocery bag in the car and close the booth again afterwards. In case the car could not be found, it was possible to remotely make the car flash the lights and honk the horn (Interviewee[08], 2015). The Roam Delivery project belongs to Volvo's new offerings department, where new, innovative products and services are tested (Interviewee[07], 2015). This particular project was chosen because of the great visibility in the media and many PR responses (Interviewee[18], 2015).

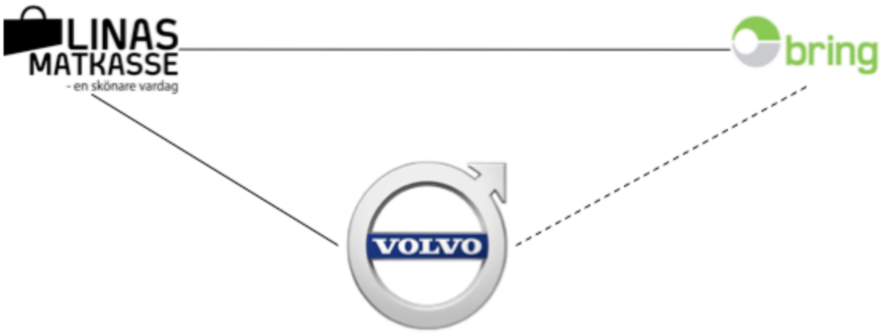

Figure 18: Driver-Centric Actor Network

5.4.1 General Settings of Collaboration

Being a project small in scale with around 500 cars during peak hours (Interviewee[18], 2015), the collaboration settings for the Roam Delivery project are different from the infotainment system. The pilot project is used to test and improve future collaborations and the product itself (Interviewee[18], 2015). The main purpose of pilot projects is to experiment and learn about applications of new technology and to understand the collaboration partner, especially, how to create value for him as a customer (Interviewee[07, 18], 2015).

"In those early stages for those kind of projects its about learning about their business model, learning about the challenges in their business and how we can solve things and create value together." (Interviewee[07], 2015)

The work is set up cross-functional, involving multiple functions within an organization (Interviewee[07], 2015). To facilitate fast learning an adaptive and flexible actor setup is needed that allows frequent feedback loops and corrections (Interviewee[07, 08, 18], 2015). Therefore no fixed setup is in place (Interviewee[07, 08, 18], 2015). The loose framework is hold together by mutual trust and only very limited legal agreements (Interviewee[18], 2015).

"You cannot offer a service level agreement, you can't offer a contract. Not in detail, because you don't know what is going to happen. It more has to be that sort of handshake, between people that understand each other." (Interviewee[18], 2015)

Even though the involved actors (mainly Volvo and Linas Matkasse) are of different size, the collaboration takes place on the same hierarchical level (Interviewee[07, 08, 17], 2015). The main reason for not having a traditional tier one supplier customer relationship is the missing proven business model that is needed for a strict collaboration setup to function (Interviewee[17], 2015).

5.4.2 Network Positions and Roles of Actors

There are only two main actors involved in the exemplary driver-centric use case of the Roam Delivery project: Linas Matkasse & Volvo (see Figure 18). Bring, the logistic partner, mainly works towards Linas Matkasse and had only be involved in the initial setup processes with Volvo (Interviewee[18], 2015).

Role of Actors

Volvo initiated the project as the main actor, closely coordinating the activities with Linas Matkasse during the whole three month pilot phase. Each actor has his own special responsibility:

- **Volvo:** Initiating actor (Interviewee[07], 2015)
- **Linas Matkasse:** Pilot Partner (Interviewee[08], 2015)
- **Bring:** Logistics Partner (Interviewee[17], 2015)

Benefits and Obligations of Actors

Both main actors, Linas Matkasse and Volvo, did not enter the collaboration for monetary reasons. The main benefit was to test the viability and grasp the potential of a new offering with real customers (Interviewee[18], 2015). In addition, great brand value and good PR emerged as a result of the pilot (Interviewee[08, 18], 2015). For Volvo, the understanding and learning of new business models and value creation mechanisms together with expected PR was the main benefit (Interviewee[07], 2015). Linas Matkasse wanted to be part of trying out something new and work with novel technology, being itself an IT driven company (Interviewee[08], 2015). They did not expect the great PR from the start (Interviewee[08], 2015).

Given the informal setup of the collaboration, the obligations on both sides were very little. Both involved actors committed to trying out if it is possible to make the processes of Roam Delivery work and to deliver the needed parts for achieving it (Interviewee[08, 18], 2015).

"We basically told them that it would be a 'throw it up, let's see if it works' innovation project. And that we will try it out and it's a reasonable test, but no one really knows what really is going to happen." (Interviewee[18], 2015)

5.4.3 Uncertainties in the Collaboration

On one hand there were many technical uncertainties that needed to be addressed and handled (Interviewee[08, 18], 2015). No actor before did a similar projects and combined new technology in this way. This makes the scalability of the solution into other markets difficult since it is unclear how the technology transfer can be achieved (Interviewee[08, 18], 2015). Together with an uncertain business case, uncertain demand and uncertain project outcome, the general conditions of the pilot are uncertain (Interviewee[07, 08, 18], 2015). This in return puts a lot of pressure on existing resources, structures and internal processes in both actor organizations that need to be dealt with (Interviewee[18], 2015). Even if all internal uncertainties are handled, there are some external uncertainties left that cannot be influenced by the involved actors (Interviewee[18], 2015).

The general approach to deal with the project specific uncertainties were to experiment as much and as fast as possible with the least resources deployed to systemically test the basic assumptions of the use case (Interviewee[07, 18], 2015). Through cheap pilot projects continuous learning was applied to incrementally improve technology and the business case (Interviewee[18], 2015). Misunderstandings were reduced by frequent communication and interchange across departments (Interviewee[07], 2015). If this does not help, organizational adjustment is needed to cope with the new speed and flexibility (Interviewee[07, 18], 2015).

"In this case we are kind of still experimenting, or trying to find out what would be the right way and the right business model to go for." (Interviewee[07], 2015)

Technological uncertainties and problems were solved through analytical thinking and involvement of experienced personal (Interviewee[18], 2015). Resources were freed to constantly be ready for ad-hoc improvements (Interviewee[08], 2015). In addition, technology and industries were scanned continuously to look for best practices and solutions that can be transferred (Interviewee[07, 17], 2015).

5.5 Environment-Centric: Road Friction Project

On one side, connectivity of a car allows the fulfillment of personal tasks with individual-related data. On the other side, it is possible to anonymously aggregate data gathered by the manifold sensors of a modern car, transmit it via the connection to a central storage and then distribute the insights gained through the combination of hundreds or thousands of data points to actors who derive value from it. This is the case in the environment-centric use cases. The exemplary Road Friction Project examined in this study measures friction data from various sensors in the car and sends the data to a cloud storage where it is aggregated and evaluated. When enough data points are available, this friction data depicts the road condition in a certain area.

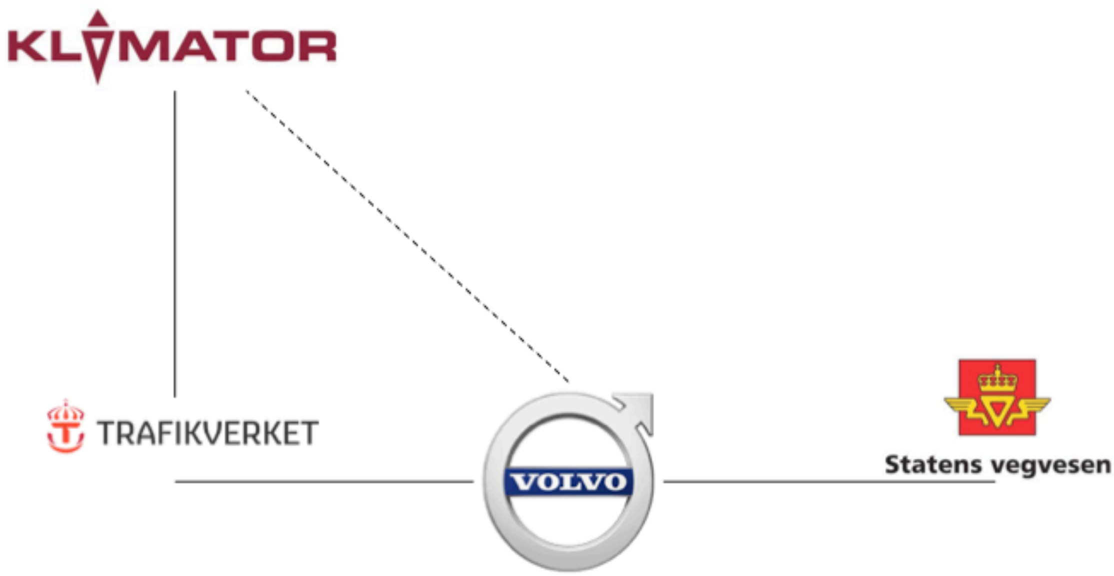

Figure 19: Environment-Centric Actor Network

In the Road Friction Project, the collaboration of Trafikverket with Volvo is the focus. Only those two companies were examined in detail. Volvo gathers the road friction information and sends the data to Klimator, who evaluates and aggregates the data and then makes it available for Trafikverket's contractors, who keep the road ice and snow free during the winter. Volvo also sends the data to the Norwegian road authority that uses the data for different purposes and helps financing the development cost (Interviewee[13], 2015). Within Volvo, the Road Friction Project is developed in the connected safety department to increase safety in Volvo Cars by providing the Slippery Road Alert functionality to its drivers (Interviewee[16], 2015).

5.5.1 General Settings of Collaboration

The Road Friction Project is setup as a pilot project during two winters (Interviewee[13], 2015). The focus lies on creating a minimum viable product (MVP) to test the functions of the new technology (Interviewee[16], 2015). Only the minimum requirements were created to be fast and first (Interviewee[16], 2015).

"It is important to make something small work rather fast so you don't want to make a concept too complicated." (Interviewee[16], 2015)

The whole setup is based on trust of all parties involved (Interviewee[07, 13, 16], 2015) with only basic contracts in place to get the minimum legal security but allow flexibility in the collaboration (Interviewee[13], 2015). The involved teams are cross-functional and stem from different departments (e.g. R&D, legal, marketing & PR) (Interviewee[13], 2015). There is no clear leader appointed in the project (Interviewee[13, 16], 2015) and the financing is unclear and shifts from phase to phase (Interviewee[13], 2015).

5.5.2 Network Positions and Roles of Actors

The two main actors involved in the Road Friction Project are the road authorities, Statens Vegvesen and Swedish Trafikverket, and Volvo (Interviewee[13, 16], 2015). Statens Vegvesen was not examined in this study to keep focus on Swedish actors (see Figure 19).

Role of Actors

The project started with Volvo approaching Trafikverket and offering the possibility to use friction data. After initial discussions, the following roles were set:

- **Volvo:** Initiating actor, data provider and coordinator between road authorities (Interviewee[07, 13, 16], 2015)
- **Trafikverket:** Data customer and coordinator between data evaluator (Klimator), data user (contractors) and Volvo (Interviewee[16], 2015)

The Road Friction Project is a special case for Volvo because they are supplier instead of customer (Interviewee[13, 16], 2015).

Benefits and Obligations of Actors

For both actors the main benefit was to understand the partner better, coming from different sectors (Interviewee[07, 13], 2015). Trying out and test new processes helped the common understanding of partner, technology and product (Interviewee[13, 16], 2015).

"This is a pilot project. We first want to see if this technology is in the status that we [Trafikverket] can use it. And another objective is to see how we can purchase this technology in the future." **(Interviewee[13], 2015)**

Especially quality assurance and accuracy testing of the data provided was useful. The pilot project worked as a brand builder for Volvo and helped to get close to and understand a potential customer of data (Interviewee[16], 2015). Trafikverket benefited by being able to better follow-up on contractors, support themin the decision making process with more and better data and evaluate a possibility to replace the fixed installations that provide road friction data at the moment through an outsourced service (Interviewee[13], 2015).

The involved actors collaborated in a flexible way with no commercial obligation (Interviewee[13], 2015), Volvo promising to provide the data (Interviewee[16], 2015) and Trafikverket indirectly funding development cost through Klimator (Interviewee[13], 2015).

5.5.3 Uncertainties in the Collaboration

The uncertainties faced during the Road Friction Project are described first before specifying what the involved actors undertook to handle and reduce them.

To make this kind of services viable, a critical mass of connected cars needs to be involved. The connectivity of future cars is seen as certain, but the speed of dissemination towards achieving a critical mass is unknown (Interviewee[07], 2015). In addition the ecosystem constellation is unclear with no central actor in the lead for aggregating vehicle data, especially across OEMs (Interviewee[07, 13], 2015).

"There are several constellations in that space, it's still not clear exactly on how that ecosystem will look like. Clearly that data is very valuable, so we will see where that ends up." **(Interviewee[07], 2015)**

The technical possibility of creating connected environment services exists, but the willingness to pay for them is unclear, there is no proven business model and business case yet on how the data can be monetized (Interviewee[07, 13, 16], 2015) and if the offering fits the customer need (Interviewee[13], 2015). Technical feasibility could be proven small scale but the scalability and the transfer into other markets is uncertain (Interviewee[13, 16], 2015).

To cope with these uncertainties, the involved actors mainly looked at other industries and applied benchmarking and networking techniques to derive solutions that can be applied for its own industry (Interviewee[07], 2015). Cross-functional organizational setups help to handle uncertainties with rapid communication across functional silos and barriers (Interviewee[07], 2015), enabling the necessary speed to conduct many fast and simple experiments that reduce complexity by breaking down big problems into actionable steps (Interviewee[13], 2015).

In summary, chapter 5 presented the empirical findings for each of the three use cases. An overall overview of all findings can be found in Appendix 5. These findings act as a foundation for the analysis in the following chapter.

6 Analysis

The analysis picks up where the theoretical foundation left off, applying the empirical findings (see chapter 5) to the theoretical framework developed in the theoretical foundation (see chapter 4). First, the specific use cases addressing the three sub-research questions are analyzed (6.1). Second, the cross-case analysis is presented (6.2). Third, the main-research question is addressed (6.3) and finally, a helicopter view on the main framework is taken (6.4) that allows a depiction of general observations (see Figure 20).

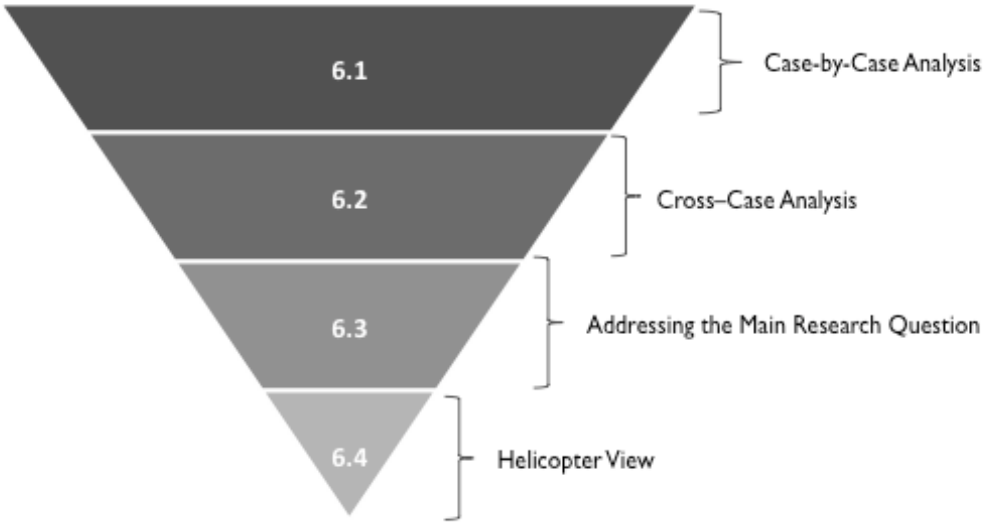

Figure 20: Analysis Structure

6.1 Case-by-Case Analysis

In this part each case is analyzed separately. General settings of collaboration, network positions & roles of actors and uncertainties in the collaboration are analyzed. Derived collaboration patterns then serve as the basis and are enriched in the cross-case analysis (6.2).

6.1.1 Car & Platform-Centric

The empirical findings indicate two different collaboration patterns within the car & platform-centric use case, in this study referred to as: Established Pattern and Transitional Pattern (see Table 3).

	Established Pattern	**Transitional Pattern**
Focus	Platform Foundation	Additional Offerings
Setting	Strict & Formalized	Flexible & Agile
Monetary Benefits	Primary	Primary
Non-Monetary Benefits	Secondary	Secondary
Obligations	All kinds	Intangibles & Services

Table 3: Collaboration Patterns in the Car & Platform-Centric Use Case

In both patterns, Volvo holds the focal network position. In the established pattern, Volvo is the only actor with direct end-customer contact. An exception is the network provider who acts within the established pattern, but has direct customer contact to provide data volume offerings (similar contracts as with smartphones). On the other hand actors within the transitional pattern have direct contact with end-customers through their offerings.

Several uncertainties are prevalent. The convergence of industries, caused by the technological IoT phenomenon, causes rapid and fast shifts in market needs (Stieglitz, 2003; Weavers, 2007) and makes the creation of a valid business case with a proven business model difficult (Mason & Spring, 2011; Zott & Amit, 2008). New technology from before disconnected industries intrudes the automotive industry, making the offerings more complex and increasingly uncertain in terms of data security, integrity and quality. These uncertainties are mainly handled through benchmarking within and across the industry (Camp, 1989) and with organizational adjustments within the OEM's organization to allow a cross-functional setup (Ford & Randolph, 1992). Besides that, close collaboration with the other actors was described as being mutually beneficial to handle uncertainties, as pointed out by Rigby & Zook (2002).

6.1.2 Driver-Centric

The empirical findings indicate one collaboration pattern within the driver-centric use case, in this study referred to as: Experimental Pattern (see Table 4).

	Experimental Pattern
Focus	Learning
Setting	Loose & build on trust
Monetary Benefits	Secondary
Non-Monetary Benefits	Primary
Obligations	Make Experiments work

Table 4: Collaboration Pattern in the Driver-Centric Use Case

To evaluate new business potentials that may lead to viable business models, the involved actors engage in open innovation (Rigby & Zook, 2002). In those open innovation projects, the network position is not relevant and both actors face each other on the same hierarchical level. Volvo takes on a different role in this collaboration pattern, being the data or service supplier instead of customer. In these experimental collaborations most aspects are uncertain. The uncertainties are handled by experimenting with continuous learning (Gassmann et al., 2010), a cross-organizational setup (Ford & Randolph, 1992) and by applying the lean start-up methodology (Ries, 2011) for intrapreneurial projects.

6.1.3 Environment-Centric

The empirical findings indicate the same collaboration pattern as in the driver-centric use case: Experimental Pattern (see Table 5).

	Experimental Pattern
Focus	Learning
Setting	Loose & build on trust
Monetary Benefits	Secondary
Non-Monetary Benefits	Primary
Obligations	Make Experiments work

Table 5: Collaboration Pattern in the Environment-Centric Use Case

The experimental pattern in the environmental-centric use case differs slightly regarding network position and actor role. Since more founding is necessary to realize this pilot project, the actors who invest the most resources have a more central network position and leading role in the collaboration (Interviewee[13], 2015). Slight differences are also seen due to the public sector context, which makes the collaboration more complex (Interviewee[16], 2015).

6.2 Cross-Case Analysis

In this cross-case analysis, the case-by-case analysis together with other empirical findings and relevant literature is used to derive answers for each research question. The sub-research questions are addressed from Volvo's point of view. These findings build the foundation to explain general collaboration patterns and address the main research question in chapter 6.3.

6.2.1 General Settings of Collaboration

To answer sub-research question 1, the settings of the use cases are compared and analyzed. The maturity stage concept of innovation processes according to Fetterhoff & Voelkel (2006) is applied to differentiate between the varying general collaboration settings of the use cases. The research shows that the use cases are in different maturity stages of innovation processes (Fetterhoff & Voelkel, 2006).

SRQ 1: How do actors within use cases define the general settings for collaboration?

In the car & platform-centric use case, clear supplier-customer relationships were identified (see chapter 5.3). They show characteristics of maturity stage five 'Extension of the Innovation Offering' as described by (Fetterhoff & Voelkel, 2006), since the collaboration is very established with strictly formalized procedures and processes and shows characteristics of traditional automotive supplier relationships. The focus of the collaboration settings with these suppliers is on inbound product innovation (Huizingh, 2011; West & Gallagher, 2006). This comes from the high strategic importance of the use case as part of Volvo's core business. The only exceptions are small content providers like Tuneln or Storyteller. Due to their limited size and novelty to the automotive industry, the contracts need to be more flexible. Process innovation exists as well, since both parties try to adapt to the new environment (West & Gallagher, 2006). Those less formalized relationships therefore show characteristics of maturity stage four 'Capturing Value Through Commercialization' (Fetterhoff & Voelkel, 2006).

Within the driver and environment-centric use cases, pilot project characteristics have been detected. They are both in an immature state, where the new technology needs to be tested and the market potential evaluated. In both use cases Volvo recruited potential development partners, but the setup is only loosely regulated with no clear obligations. Therefore, both can be seen in the early stage of 'Evaluating Market Potential and Inventiveness', as described by (Fetterhoff & Voelkel, 2006). The open innovation process is both inbound and outbound, meaning that the results are not only focused on the benefits for Volvo, but also on the benefits for Linas Matkasse or Trafikverket (Huizingh, 2011). The focus is thereby on both product innovation and process innovation. New ways of working need to be established in order to accommodate the interests of all parties (West & Gallagher, 2006). The frameworks of the driver- and environment-centric use case collaborations are built on mutual understanding and trust instead of legal obligations and strict contracts. It is important to find a partner with complementary capabilities (Enkel & Heil, 2014; Gawer & Cusumano, 2014). A limited project scope is important to not to be too resource exhaustive and to create a MVP first to proof the concept (Moogk, 2012). Experimentation and ad-hoc problem solving are paramount (Gassmann, 2010).

The comparison of maturity stages between the different use cases shows stage two for actors within the experimental collaboration pattern, stage four for actors within the transitional pattern and stage five for the established pattern. This indicates that the actors define the general setting of collaboration in different ways, depending on the maturity stage of the innovation process.

6.2.2 Network Positions and Roles of Actors

To answer sub-research question 2, the roles of the focal actor are discussed. Benefits and obligations of the collaboration are analyzed and finally the impact on changing network position of the focal actor is outlined. The platform differentiation and associated strategic network roles according to Enkel & Heil (2014) are applied to the use cases.

SRQ 2: How does the focal actors' network position and role change between the use cases?

The empirical findings have shown that Volvo is taking different strategic network roles between the cases:

In the car & platform-centric use case, Volvo is the focal point towards the end-customer and finally assembles the white-label products of its suppliers. It owns the key resources and coordinates the efforts in the value creation process. Its strategic network role can be described as a solution integrator, as defined by (Enkel & Heil, 2014).

An exception is the collaboration with Telenor Sweden and content providers like Pandora, where Volvo is taking a service mediator role (Enkel & Heil, 2014). Volvo is using the services of these actors to enable and enhance their product, but therefore loses the full control over the direct customer contact. Telenor and the content providers have direct customer contact over their products.

In the driver- & environment-centric use case, the strategic network role of the focal actor is not yet defined because of the early development stage of the collaboration. The main goal is the exploration of the opportunity, as described by (Lichtenthaler & Lichtenthaler, 2009). In a later stage and when it comes to commercialization, a strategic network role will need to emerge. It is interesting to note that in both use cases, Volvo acts as a supplier instead of a customer, either for their earlier partners (Linas Matkasse or Trafikverket) or for other interested parties. This can be described as a reversed supplier-customer relationship. This is contrary to the traditional customer role of the OEM in the car & platform-centric use case with a traditional tier-one supplier network.

Looking at the main benefits and obligations, we can see a clear split between the use cases. The car & platform-centric use case is mainly driven by financial benefits, which applies to both identified collaboration patterns. Soft benefits like expertise and know-how from other industries were described as less important. The obligations in turn are clearly fixed in the initial contracts. Contrary, the benefits of the driver- and environment-centric use cases are mainly of soft nature and non-monetary. These cases focus on trying out the potential and product characteristics and learning from the collaboration partner and potential customer. This is in line with the key benefits of open innovation outlined by Rigby & Zook (2002), Lichtenthaler (2007), Nagaoka & Kwon (2006). In the driver- and environment-centric use cases there were no commercial obligations from the start. The involved parties only committed to contribute with their resources and capabilities and a willingness to adapt as the project developed (Lichtenthaler & Lichtenthaler, 2009), emphasizing the flexible and agile settings in the collaboration.

The analysis showed that Volvo's strategic network role shifts over time depending on the collaboration pattern. For the explorative collaboration pattern, the role is not yet defined. In the transitional collaboration pattern Volvo takes on the role as service mediator and in the established collaboration pattern the strategic network role shifts towards service integrator.

Those shifts have implications on Volvo's network position, taking on a more central and controlling position over time while moving from exploration to establishment.

6.2.3 Uncertainties in the Collaboration

To answer sub-research question 3, first the uncertainties are analyzed and then the approach to handling these uncertainties is discussed. Uncertainties in B2B customer-supplier relationships according to Ford et al. (2002) are used to structure the uncertainties described in the empirical findings.

SRQ 3: What are the main uncertainties within each use case and how do the actors handle those?

Three major uncertainties are reoccurring throughout all use cases within the empirical findings: Predominantly, business case uncertainties in combination with market need uncertainties emerged as the biggest challenges for the actors, especially in a fast changing market environment. The main prevailing question is how to monetize the new services and offerings (Chesbrough & Rosenbloom, 2002). Besides that, technological uncertainties are present, but these are described as natural in development projects and perceived as solvable (Chesbrough H. , 2004).

Uncertainties apply to all actors in the development of the connected car platform and are shared between them. Even though uncertainties are shared among the different actors, in the car &

platform-centric use case it was pointed out that the OEM carries most of the weight of the uncertainties, since he 'owns the last mile' towards the end-customer. The OEM commits to long-term fixed contracts with the suppliers on one side, but faces capacity uncertainty and volatility of their end-customers on the other side (Ford et al., 2002).

The convergence of industries leads to many available new technologies and solutions for the customer (in this case the OEM) to choose from. This increases market uncertainty and complicates the decision about what solution to buy (Ford et al., 2002). In addition need uncertainties exist for the OEM whether the offerings he buys from the suppliers match the uncertainties he is facing and whether they lead to the best product he can offer his customers (building the best Volvo cars possible) (Ford et al., 2002). For suppliers in the driver & environment-centric use case, application uncertainty is crucial (Ford et al., 2002). Since the outcome of the collaboration is unclear, it is hard to anticipate how the customer can use the delivered offerings most efficiently.

In the driver and environment-centric use cases, uncertainties concerning national borders were found. Due to the national focus of the pilots, the scalability to other markets was uncertain and is caused by multiple factors: Uncertainties about the ecosystem constellation in the future, different shares of potential Volvo cars in different markets and uncertainties about the speed of the diffusion of innovation to reach a critical mass (Mahler & Rogers, 1999; Valente, 1995).

Looking at how to handle uncertainties, two main strategies were found throughout all use cases. First, active benchmarking across industries was conducted to find best practices (Camp, 1989). Second, internal cross-functional setup is constructed to handle uncertainties across functional silos (Ford & Randolph, 1992). Besides that, close collaboration involving frequent and open communication with the other actors was described as mutually beneficial to handle uncertainties, as also outlined by Rigby & Zook (2002).

The driver and environment-centric use case have shown the importance of keeping the projects small, in order to stay agile and not being to resource exhaustive for producing a MVP first. The importance of experimentation in technology driven environment was shown in research (e.g. Moogk, 2012).

Summarizing the findings of the analysis, the following three main uncertainties were found that are faced by the actors of the Connected Car platform:

Market & Need Uncertainty: How to anticipate the end-customers problems and needs and how to solve them by prioritizing and buying the right solutions from the supplier.

Business Case Uncertainty: How to monetize the connected offerings.

Technological Uncertainty: How to solve complex technological challenges and problems.

The empirical findings have shown that the uncertainties are the highest in the explorative collaboration pattern and can be reduced once the commercialization in the transitional phase is set in place. In the established collaboration pattern long-term need anticipation is still difficult, although the gained experience and stable structures help to further reduce uncertainties compared to the earlier stages.

6.3 Addressing the Main Research Question

This chapter combines the findings from the case-by-case and cross-case analysis and describes three distinct collaboration patterns in detail to answer the main research question:

MRQ: What collaboration patterns occur as a consequence of the introduction of new Internet of Things based technological platforms?

The case-by-case analysis indicated three different collaboration patterns (established, transitional & experimental) with four distinct characteristics (focus, settings, benefits & obligations). The cross-case analysis enriched the three collaboration patterns with three additional characteristics (maturity stage, network role & uncertainties), which were derived from answering the sub research questions.

Table 6 provides an overview of the collaboration patterns and their characteristics:

	Established Pattern	**Transitional Pattern**	**Experimental Pattern**
Focus	Platform Foundation	Additional Offerings	Learning
Setting	Strict & Formalized	Flexible & Agile	Loose & Build on trust
Monetary Benefits	Primary	Primary	Secondary
Non-Monetary Benefits	Secondary	Secondary	Primary
Obligations	All kinds	Intangibles & Services	Make Experiments work
Maturity Stage	Five	Four	Two
Strategic Network Role of Focal Actor	Solution Integrator	Service Mediator	Not yet defined
Uncertainties	Medium	Medium	High

Table 6: Summary of Collaboration Patterns

At this point it is of importance to note the connection between use cases and collaboration patterns. Use cases describe a fixed point of view on the connected car and are static differentiations that help to classify actors into sub-systems according to specific customer offerings (Adolph et al., 2002; Bittner, 2002; Anderson et al., 2006). Collaboration patterns then are introduced to represent a dynamic perspective that is changing continuously over time. Collaboration patterns characterize the dynamics of collaboration between the actors in the described static use cases. They need to be seen as 'fluid', since the change from one collaboration pattern to the next is seamless with no clear borders.

The established pattern entails actors that focus on providing the platform foundation. The participants are established suppliers. All involved firms participate in the platform primarily for monetary reasons (Rigby & Zook, 2002; Dahlander & Gann, 2010). Non-monetary reasons such as knowledge are also of concern (Sousa, 2014; Jacobide & Billinger, 2006), but do not have the same importance. This collaboration pattern can involve different sorts of deliverables from the involved actors, ranging from tangible products to services and intangible offerings (data or software). The platform type of the established collaboration pattern fits the multi-sided industry platform definition of Enkel & Heil (2014) with the focal actor taking on a central network position and acting as a solution integrator. The focal actor incorporates all the deliverables from the other participants within the use case in his own offering and is actively controlling the platform (Enkel & Heil, 2014). The structures such as legal framework or work and communication processes of the collaboration within this pattern are stable and formalized, representing the experience and standards of the focal actor. Collaborations within this pattern show characteristics of maturity stage five of innovation processes "extending the innovation offering" (Fetterhoff & Voelkel, 2006). Those collaborations were shaped over a longer period of time and are not newly created. This leads to reduced uncertainties compared to the other patterns, but uncertainties about anticipating business and market needs due to the novelty of the technology (Ford et al. 2002; Stieglitz, 2003; Weavers, 2007) remain. Uncertainties are handled through benchmarking (Camp, 1989), close collaboration (Rigby & Zook, 2002) and an internal cross-functional setup (Ford & Randolph, 1992).

The transitional pattern is seen as the passage between the experimental and the established pattern. Commercialization of the provided offering is ongoing but not yet fully developed. Monetary reasons for collaboration are relevant, but learning and experience exchange is also of major importance (Sousa, 2014; Jacobide & Billinger, 2006). The involved actors in this pattern are creating additional offerings that are complementary to the platform and enrich the platform foundation with additional functionality. The provided offerings are services or intangibles with a short lifecycle. They can be streamed and updated onto the car and therefore collaboration in this pattern is not dictated by the lead times of the car (Kopczak, 2003). Compared to the established pattern, the focal player in this pattern allows other firms to have direct end-customer contact. The settings are flexible and agile, enabling fast reaction in the rapid changing environment. The maturity stage of innovation processes show characteristics of stage four "capturing value through commercialization" (Fetterhoff & Voelkel, 2006). Since direct end-customer contact for data exchange and services is granted, the focal actor takes on the role as a service mediator, connecting relevant stakeholder over the platform (Enkel & Heil, 2014). The focal actor takes a central network position by owning the platform and facilitating the transactions between the stakeholders (Enkel & Heil, 2014). Due to the nature of the provided offerings in this pattern and its fast changing environment, external uncertainties about market needs and development are prevalent (Ford et al., 2002; Stieglitz, 2003; Weavers, 2007). In addition, the lacking commercialization of the offerings raises business case uncertainties (Mason & Spring, 2011; Zott & Amit, 2008). Comparable to the established pattern, uncertainties are handled through benchmarking, close collaboration and an internal cross-functional setup.

The experimental pattern characterizes companies that collaborate mainly in order to learn from each other and their respective market (Rigby & Zook, 2002; Lichtenthaler, 2007). Focus lies on experimentation and testing of basic assumptions of the pilot projects. The collaborations are in an immature state, where the new technology needs to be tested and the market potential evaluated. They can be seen in maturity stage two of innovation processes "evaluating market potential", as described by Fetterhoff & Voelkel (2006). Emphasis lies also on innovating the collaboration processes, which is new for the big organizations involved (West & Gallagher, 2006). Monetary reasons for participating are secondary, mainly since proof for a sound business case does not yet exist. The collaboration settings are informal and mainly built on trust. The loose setup allows rapid adaption to changing circumstances. The collaboration is continuously formed and developed with newly gained insights and a focal actor in the center of the network has yet to emerge. Knowledge-based assets and the source of funding decide about position power (Coff, 1999). Collaborations within the experimental pattern are newly formed and act in an environment of great uncertainty. Manifold uncertainties about the development and survival of the collaboration itself, about business and market needs (Ford et al., 2002; Stieglitz, 2003; Weavers, 2007) as well as technological feasibility of the projects are identified. As in the other patterns, actors handle uncertainties with benchmarking, close collaboration and an internal cross-functional setup. Besides that, these immature projects follow a trial and error strategy, focusing on MVP first (Moogk, 2012).

Besides the identified collaboration patterns, it is important to note the automotive specifics of the collaboration in the case context. Traditionally, the collaboration and value chain in the automotive industry are dictated by the automotive product lead times, which can take between 36 and 48 months (Charney, 1991). With the connectivity of the car, streamed content can now be changed and new business cases can be established throughout the lifecycle of the car. Once the basic infrastructure and hardware are in place, the collaboration in these cases is therefore no longer dictated by the product lead times of the car (Kopczak, 2003).

6.4 Helicopter View

The research showed that a dynamic view is necessary to identify and describe collaboration patterns on IoT based technological platforms. The analysis of the Volvo's Connected Car platform divided into 'static' use cases lead to the emergence of dynamic and fluid collaboration patterns that change over time. Due to the novelty of the platform, all actors engage in collaborative innovation activities or open innovation. In this helicopter view, the abstraction level is increased and two suggestions about collaboration patterns on platform-centric networks are made:

(1) Collaboration patterns change in accordance to maturity stages of innovation processes and together build a dynamic dimension of collaboration.

(2) The one-to-one relationships within a platform-centric network change depending on maturity stage and collaboration pattern within the dynamic dimension of collaboration.

First, the analysis suggests a relationship between maturity stages and the general settings of collaboration as well as network positions and roles. In early stages, experimentation and ad-hoc problem solving characterize the general settings of collaboration. In later stages, collaboration is more formalized and follows established processes and procedures. A similar relation was seen for network positions and roles. In early stages clear network position and roles are not yet established. With maturity of the partnerships and formalization of collaboration, network positions are taken and clear roles are assigned.

As shown in Figure 21, this study therefore suggests the assignment of collaboration patterns according to maturity stages of innovation processes defined by Fetterhoff & Voelkel (2006): (1) seeking opportunities, (2) evaluating their market potential and inventiveness, (3) recruiting potential development partners, (4) capturing value through commercialization, and (5) extending the innovation offering. Depicted in Figure 21, the 'Experimental Pattern', 'Transitional Pattern' and 'Established Pattern' follow the innovation process stages. Thereby, a clear-cut allocation is not intended. It rather shows a fluent transition between the different collaboration patterns following the innovation process development.

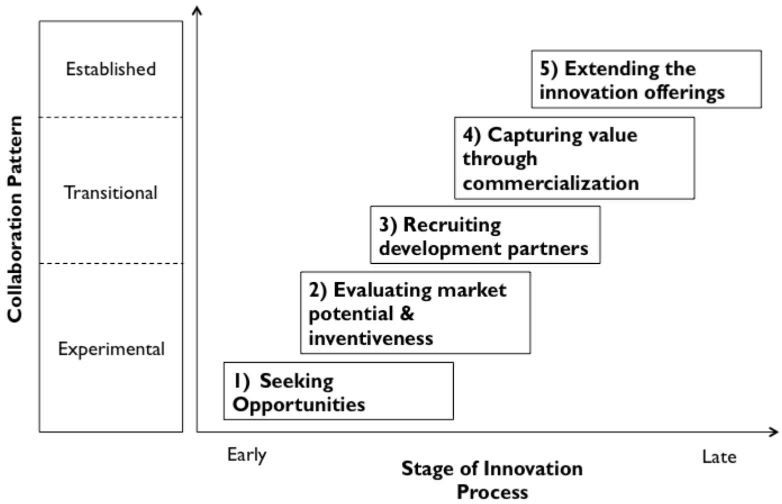

Figure 21: Dynamic Dimension of Innovative Collaboration

Second, this study observed that the one-to-one relationships between the focal actor and the other actors on the platform are shifting over time. In new and explorative collaborations, a partnership is prevalent in order to drive innovation through mutual exchange with a partner that contributes with complementary capabilities. At a later stage, the focal actor is either taking a supplier role, providing offerings towards customers, or acts as a customer, specifying deliverables. As shown in Figure 22, this study therefore suggests a relationship model, where the actors have different one-to-one relationships, depending on the maturity stages and collaboration patterns in the dynamic dimension of collaboration. These can either be partnerships, supplier-customer relationships or customer-supplier relationships.

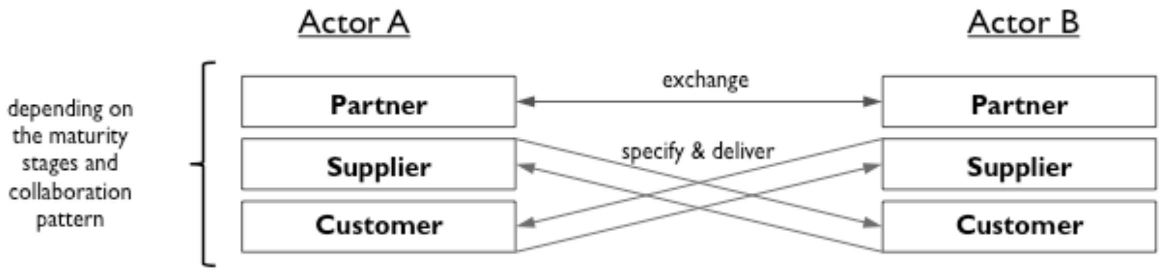

Figure 22: Changing One-to-One Relationships

7 Conclusion

The purpose of this study is to contribute to the existing literature by developing knowledge about inter-organizational collaboration patterns emerging on Internet of Things based platforms. For this purpose, an exploratory case study divided into pre-study and main study was conducted in order to answer the main research question:

What new collaborations patterns occur as a consequence of the introduction of new Internet of Things based technological platforms?

The pre-study applied the Turber et al. (2014) framework as a structuring device with the purpose of narrowing down the research focus by identifying key aspects of collaboration that are essential to explain the main research question. It showed that due to the novelty of the IoT platform in the automotive industry, the involved actors engage in collaborative innovative activities (open innovation). The pre-study also showed that a static mapping device is a useful tool to identify key actors and their IoT specific value contribution on the platform, but that it is not sufficient for analyzing collaboration. Use case differentiation is needed to classify the involved actors into sub-systems, in which actors collaborate to provide a specific customer offering. These use cases allow a detailed examination of three key aspects of collaboration that were detected in the pre-study and which guide the main study: The general collaboration setting, the network position & role of the focal actor and the uncertainties in the collaboration.

In the main study three ideal-type use cases were chosen that represent the most widespread perspectives on the connected car: Car & platform-centric, driver-centric and environment-centric. The in-depth analysis of the key aspects of collaboration within the use cases identified three collaboration patterns: (1) Experimental Pattern, (2) Transitional Pattern and (3) Established Pattern. The patterns characterize the dynamics between the actors in the static use cases and outline varying collaboration settings and network positions & roles with different levels of uncertainty.

The established pattern entails actors that focus on providing the platform foundation. Primarily, actors participate for monetary reasons. Non-monetary reasons are secondary. The focal actor takes on a central network position and acts as a solution integrator, incorporating the deliverables of the other actors in his own offering and owning the last mile towards the end-customer. The structures such as legal framework or work and communication processes are stable and formalized and follow automotive industry standards. In the established collaboration pattern uncertainties are lower compared to the other patterns, but market-facing uncertainties remain concerning anticipating business and market needs.

The transitional pattern is seen as the passage from the experimental to the established pattern. Focus is on creating additional offerings that are complementary to the platform and add additional functionality. Offerings are intangible and new to the industry. Commercialization of the provided offering is ongoing but not yet fully developed, nurturing business case uncertainties in combination with uncertainties about market development and needs. Monetary reasons are primary, but learning and experience exchange are also of major importance. The settings are flexible and agile, enabling fast reaction in the rapid changing environment. The focal actor takes on a new role as a service mediator, connecting relevant stakeholders over the platform and allowing access to the end-customer.

The experimental pattern is characterized by companies that collaborate mainly in order to learn from each other and their respective markets. Focus lies on experimentation and testing of basic assumptions of innovations. Monetary reasons for participating are secondary, mainly because proof for a sound business case does not yet exist. The collaboration settings are informal and mainly build on trust. The loose setup allows rapid adaption to changing circumstances. The collaboration is formed and developed with new insights gained and a focal actor in the center of the network has yet to emerge. The collaborations are newly formed and act in an environment of manifold uncertainties: Uncertainties about the development and survival of the collaboration itself, about business and market needs as well as technological feasibility of the projects.

Besides the identified patterns, the study suggests a conceptualization that assigns the collaboration patterns according to maturity stages of innovation processes described by Fetterhoff & Voelkel (2006). It was shown in this study that the three collaboration patterns follow the innovation process stages (1) seeking opportunities, (2) evaluating their market potential and inventiveness, (3) recruiting potential development partners, (4) capturing value through commercialization, and (5) extending the innovation offering. A fluent transition of the different collaboration patterns following the innovation process development is proposed.

Finally, and in line with the collaboration patterns and maturity stages, this study suggests that one-to-one relationships between the focal actor and other actors on the platform are shifting over time. The study proposes a relationship model, where actors are in differing one-to-one relationships, depending on the maturity stages and collaboration patterns in the dynamic dimension of collaboration. These can be partnerships, supplier-customer relationships or customer-supplier relationships.

8 Discussion

In the following discussion theoretical (8.1) and managerial (8.2) implications are presented and the limitations (8.3) of this study are outlined. Finally, based on the analysis and limitations, future research fields (8.4) are illustrated.

8.1 Theoretical Implications

The research has shown that static structuring devices like the Turber et al. (2014) framework help to illustrate platform-centric networks, but lack a dynamic perspective in order to describe the interaction between actors. The study at hand explores a new dynamic 'How' dimension to advance the research in the field of collaboration in platform-centric networks in an IoT context.

Two main contributions to the current literature are derived.

First, three patterns of an automotive IoT platform were identified that characterize its inter-organizational collaboration. These patterns have been found to be in relation to maturity stages of innovation processes. Each of the collaboration patterns contains specifications of collaboration setting, network position & roles and uncertainties.

Second, an approach to analyze inter-organizational collaboration in IoT based platform-centric networks is presented, that can guide future research. In a first step, the knowledge foundation can be built with a static mapping of the involved actors and their value contribution. Here, use cases need to be differentiated, that help to structure platforms into sub-systems. Building upon this base, the dynamics of collaboration can be approached in a second step following elaborated collaboration patterns. These patterns describe how actors collaborate to create use case-specific offerings. The study showed that these patterns can be differentiated according to maturity stages of the innovation process.

With both theoretical implications, this study lays the groundwork for the development of a holistic and dynamic understanding of inter-organizational collaboration in an IoT based platform-centric network.

8.2 Practical Implications

The study provides several insights into how practitioners can analyze the static platform their company is involved in and act accordingly. First, an approach to analyze IoT platforms is presented. Second, it is shown how collaboration patterns can be used to choose a suitable collaboration setting. Third, identified ways for handling uncertainties are listed and finally, it is shown how the differentiation of platform types helps the focal actor to define the ideal strategic network role.

Approach to Analyze IoT Platforms: The approach can be used to support decision-making and can help to design complementary offerings that create synergies by stimulating co-evolution between actors. First, a structuring device like Turber et al. (2014) can be applied to get an overview of an IoT platform with its involved actors engaging on different layers within the architecture. Second, a distinction of the overall platform into use cases is useful to understand platform sub-systems and to prepare for the collaboration pattern analysis. Third, the dynamic dimension of collaboration can be analyzed to identify collaboration patterns and maturity stages.

Comparison of Collaboration Settings: By identifying the focus or maturity stage of collaboration, implications on the collaboration patterns can be made. The derived collaboration patterns in this study can serve as source of comparison for the practitioner's specific collaborations.

Definition of Ideal Strategic Network Role for the Focal Actor: Through the identification of the use case specific type of a platform (multi-sided platforms, industry platforms or multi-sided industry platforms) ideal strategic network roles (service mediator, solution integrator or solution orchestrator) can be derived that align the focal actor with the given network characteristics to ensures platform leadership. (Enkel & Heil, 2014)

Handling Uncertainties: The analyzed actors from multiple industries named three widespread methods to handle different kinds of uncertainties that can be applied by practitioners: Choosing a cross-functional organizational setup, applying industry benchmarking and engaging in frequent communication and exchange with other platform actors, inside and outside of the own use case.

8.3 Limitations of the Research

The limitations of the methodology are described in chapter 2.4. Here, the limitations of the analysis are described.

8.3.1 Generalizability of the Findings

The collaboration patterns represent a collection of characteristics derived from empirics and are enriched with relevant theory from the fields of platform-centric networks, inter-organizational collaboration and open innovation. The patterns represent the first identification and description of collaboration patterns on IoT based platform-centric networks so far. Even though patterns of collaboration between the different use cases and involved actors were identified, the number of researched collaborations is limited. The findings may be indicative of a nascent theory, but the scope of the thesis does not cover whether or not the findings are generalizable beyond this case. A higher number of cases would be needed to validate the patterns that were identified.

8.3.2 Depth & Level of Detail

The collaboration patterns were identified on a high, explorative level analyzing particular characteristics of collaboration that were identified during the pre-study. Therefore, the study at hand does not claim to deliver an overall encompassing picture of inter-organizational collaboration. Hence, future research to further specify the process dimension ('How' dimension) will be needed. The scope of this study is delimited on the B2B setting, considering Volvo and the Volvo dealers as one unit and not analyzing end-customers. The identified patterns were therefore not analyzed in regards to car dealers and end-customers.

8.4 Future Research

Based on the analysis and identified limitations, new fields for future research arise.

First, the derived suggestions would benefit from a proof of concept demonstration and validation. The characteristics of the collaboration patterns and maturity stages would need to be validated in a different setting in the automotive industry. It would also be of interest to analyze whether the patterns can be applied to other industries and other types of platforms (e.g. digital platforms in general). Thereby, IoT specific characteristics of collaboration could be isolated and analyzed.

Second, the B2C perspective would benefit the research in this field. This study benefits from its focus on the B2B setting only. Therefore, research on the collaboration with car dealers and end-customers would complement the study at hand. Thereby, it would be interesting to analyze the impact of IoT innovations on car dealers and end-customers.

Last, future research should further explore the identified dynamic 'How' dimension within the IoT context. On a network perspective, researches could apply the three network elements actors, resources and capabilities of (Hakansson & Snehota, 1995) (see chapter 3.2.2). This would help to understand the fundamentals of the IoT based platform-centric networks. With a one-to-one relationship perspective, future research could assess individual collaborations with the effect parameters actor bonds, activity links and resource ties of Hakansson & Snehota (1995). The effect parameters could be combined with the finding of changing actor roles of this study (see chapter 6.4). Future research could outline how these effect parameters differ between supplier–customer relationships and partner relationships in an IoT environment.

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Appendix

Appendix 1 – Interviews Overview

List of Interview Partners

Role/Title	Company
Senior Vice President International	Bring
Senior Vice President Interior Electric Solutions	Continental
Business Manager	Cybercom
Principal Consultant for Intelligent Transport Systems	Ericsson
Strategic Sales Director – Head of Connected Vehicle Cloud	Ericsson
Assistant to Vice President	Ericsson
Logistics Manager	Linas Matkasse
Deputy General Manager	Mitsubishi Electrics
Project Manager	Mitsubishi Electrics
Global Account Manager	Nokia HERE
Key Account Manager	Telenor Connexion
Senior Key Account Manager	Telenor Sweden
Project Manager	Trafikverket Sweden
Vice President Electrical & Electronic Systems	Volvo Cars
Manager In Car App Development Team	Volvo Cars
Director Connectivity Strategy	Volvo Cars
Project Manager	Volvo Cars
Director Market Development	Volvo Cars
Managing Director	Wireless Car
Solution Manager 1	Wireless Car
Solution Manager 2	Wireless Car

Interviews Pre-Study

Nr.	Participant Expertise	Participant Company	Date	Length	Transcript & Notes Volume
1	Strategic Consulting	Ericsson	13.03.2015	60min	6’856 words
2	Strategic Management	Volvo Cars	16.03.2015	35min	3’571 words
3	Strategic Management	Continental	17.03.2015	35min	3’566 words
4	Project Management	Ericsson	23.03.2015	30min	2’684 words
5	IT Management	Volvo Cars	25.03.2015	45min	6’122 words
6	Sales	Ericsson	26.03.2015	35min	4’526 words
Total				**240min**	**27’325 words**

Interviews Main-Study

Nr.	Participant Expertise	Participant Company	Date	Length	Transcript & Notes Volume
7	Strategic Management	Volvo Cars	07.04.2015	45min	5’429 words
8	Logistics	Linas Matkasse	10.04.2015	30min	3’515 words
9	Strategic Management	Wireless Car	10.04.2015	70min	8’787 words
10	Project Management	Wireless Car	10.04.2015	70min*	8’787 words*
11	Project Management	Wireless Car	10.04.2015	70min *	8’787 words*
12	Sales	Nokia HERE	13.04.2015	30min	4’457 words
13	Project Management	Trafikverket Sweden	14.04.2015	75min	5’371 words
14	Project Management	Mitsubishi Electrics	14.04.2015	40min	5’949 words
15	Strategic Management	Mitsubishi Electrics	14.04.2015	40min*	5’949 words*
16	Project Management	Volvo Cars	16.04.2015	30min	5’660 words
17	Strategic Management	Bring	17.04.2015	35min	2’362 words

18	Project Management	Volvo Cars	20.04.2015	60min	6’614 words
19	Sales	Cybercom	28.04.2015	25min	1’944 words
20	Sales	Telenor Sweden	29.04.2015	60min	7’219 words
21	Sales	Telenor Connexion	29.04.2015	60min*	7’219 words*
Total				**500min**	**57’307 words**

*: Multiple persons in one conference call

Pre- & Main-Study Volume combined

Total	**740min**	**84’632 words**

Appendix 2 – Pre-Study Interview Guideline

Topic: Collaboration Patterns on the Connected Car Platform

Sample

Platform partners[1]:

- Automotive OEM's
- Dealerships
- Automotive repair shops
- Network operator
- Insurance companies
- Support Center
- App Developer
- Automotive suppliers
- Media agencies
- Network provider
- Energy/ Utility companies
- Content/ service provider
- (Fleet company)

Industries: Automotive, Telecom, IT, …

Estimated Interview timeframe: 30-40 min

Interview Guide

Company name: Date:

Place: Time/Duration: …

Type of interview: (Phone) (Live)

1. Introduction of the topic

- Research question: What new collaboration patterns occur as a consequence of the introduction of new Internet of Things based technological platforms? (Case Study Volvo's Connected Car)
- Focus on technological platforms – seen as a mediator between different actors (bringing companies and industries together)
- What are we looking for: Way of collaboration with different actors on the connected car and benefits and challenges
- What do we already know? What companies we already interviewed.
- Ask: How much time? Can we record?

2. Goal of the interview

- Mapping of the network surrounding the connect car platform
- Analyzing the current collaboration processes

[1] 2014_Ericsson_Company Report_Connected Vehicle Cloud - Under the hood

[2] Four-layer architecture from Turber et al. (2014): Device, Network, Service, Content

3. Term definition

- Collaborators = partners, (customers) and other stakeholders of the platform

4. Structure of the qualitative interview:

General

1. What is your personal background and role at company xy?
2. How are you involved in the Connected Car project?
3. How do you collaborate with Volvo? Connected Car?

Collaboration Patterns for Internet of Things Platforms

Where

4. Where does your company create value for the consumer of the platform? (Focus on end-consumer) What do you do yourself? What do you outsource?
    - Where exactly?
        - Device – physical platform
        - Network
        - Service
        - Contents
5. Where do you create value for the development process of the Connected Car platform? (Focus on development process of the platform with other actors)

Why

6. What are your company's reasons to participate in the platform development?
    - Monetary?
    - Non-monetary?
7. Under what circumstances would you withdraw from the platform development?

Who

8. What are the most important tasks to develop and operate the platform?
9. Who are the other actors and collaborators of the platform?
10. Who do you work most and least frequent with?
    - Why?
11. How do you collaborate with the other actors?
    - Supporting questions:
        - What function in your team is in charge of the collaboration?
        - At which layer[2] do you collaborate?
        - How do you share information?
        - How do you ensure ownership of data and ideas?
        - How frequent do you communicate with other players?
12. What are the main challenges in the collaboration with players in different industries?

[2] Four-layer architecture from Turber et al. (2014): Device, Network, Service, Content

- Support dimensions:
  - Working & communication dimension
  - Information, data & ownership dimension
  - Strategy and mutual goals dimension
  - Different customer vs. consumer of actors
  - Convergence of industries/ new actors

13. How would you describe the critical moments in the build-up process of the network/platform creation?
14. Other players?

Appendix 3 – Main-Study Interview Guideline

Topic: Collaboration within Use Cases of the Connected Car

Sample: Relevant use cases of Volvo's Connected Car Platform

Road Friction Project	Roam Delivery Project	XC 90 Infotainment Development
- Volvo	- Volvo	- Volvo
- Trafikverket	- Linas Matkasse	- Ericsson
- Statens Vergesen	- Bring	- Content Provider
		- Cybercom
		- Mitsubishi Electrics
		- Telenor
		- Wireless Car

Industries: Automotive, Telecom, IT, …

Estimated Interview timeframe: 30-40 min

Interview Guide

Company name: Date:

Place: Time/Duration:

Type of interview: (Phone) (Live)

1. Introduction of the topic

- Research question:
    - o What new collaboration patterns occur as a consequence of the introduction of new Internet of Things based technological platforms? A case study in the Swedish automotive sector analyzing Volvo's Connected Car."
- Focus on technological platforms and their use cases – seen as a mediator between different actors (bringing companies and industries together)
- What are we looking for: Ways of collaboration with different actors on specific use cases of the connected car
- What do we already know? What companies did we already interview?
- Ask: How much time? Can we record?

2. Goal of the interview

- Understand how the collaboration differs between the use cases?
- Understand the roles of the involved companies, existing uncertainties and the general set-up

3. Sub-research questions

1.1.: How do actors within use cases define the general settings for collaboration?

1.2.: How does the focal actors' network position and role change between the use cases?

1.3.: What are the main uncertainties within each use case and how do the actors handle those?

III. Interview Guideline

1. General

1. What is your personal background and role at Volvo?
2. How are you involved in the use cases (Road Friction/Roam Delivery/Infotainment)?
    - Note for interviewee: focus on relevant use cases from here on!

2. Network position & roles of actors

1. What is your company's role in the projects? How does it change between the project?
2. What is the role of the other involved companies in the project?
3. What are your benefits of the collaboration?
4. What are your obligations of the collaboration?

3. Uncertainties

1. Which uncertainties are you facing in the projects?
    - Dimensions for interviewer:
        - Need uncertainty (Uncertain what would be the best solution for one's problem)
        - Transaction uncertainty (Whether a particular customer/supplier can be trusted)
        - Capacity uncertainty (Amount of the offering that is likely to sell)
        - Market uncertainty (How to cope with changes in technology or the surrounding network of suppliers)
        - Application uncertainty (How customers might want to use the offering)
2. How do you handle these uncertainties?
    - Dimensions for interviewer:
        - Within your organization
        - Together in the collaboration

4. Settings of collaboration

1. What are the main factors that constitute the basis of the collaboration? Does this change between the different use cases?

- Dimensions for interviewer:
  - Legal framework
  - Processes
  - People & Responsibilities
  - Goal setting
  - Project Plan & Timeline
  - Resources & Budget

2. How does this impact the collaboration with the involved actors?
3. How do you invest into the collaboration to increase effectiveness and efficiency?

Appendix 4 – Profile of Involved Actors

Volvo Car Group

Volvo is the focal actor within the connected car platform.

Industry:	Automotive (OEM)
Headquarter:	Gothenburg, Sweden
Employees:	24'139 (Volvo Car Group, 2015)
Revenue:	15.5 billion USD in 2014 (Volvo Car Group, 2015)
Global reach:	100 countries (Volvo Car Group, 2015)
Notes:	Retail and after-sales with direct customer contact is conducted by the car dealers (Interviewee[18], 2015). For simplicity reasons, both parties will be considered as one unit called Volvo in the following parts.

Ericsson

For Volvo's Connected Car, Ericsson is providing the Service Enablement Platform and acts as a Cloud Service Provider in the Car & Platform-Centric use case.

Industry:	Telecommunication
Headquarter:	Kista, Stockholm, Sweden
Employees:	118'055 (Ericsson, 2015)
Revenue:	27.14 billion USD in 2014 (Ericsson, 2015)
Global reach:	180 countries (Ericsson, 2015)

WirelessCar

WirelessCar is the provider of the basic telematics solutions in the Volvo cars and actively participates in the Car & Platform-Centric use case.

Industry:	Automotive (Telematics)
Headquarter:	Gothenburg, Sweden
Employees:	35 (Orbis, 2007)
Revenue:	12.2 million USD in 2007 (Orbis, 2007)
Global reach:	50 countries (WirelessCar, 2015)
Notes:	Originating from a joint venture between Ericsson, Telia Sonera and Volvo in 2000 (Interviewee[09], 2015)

Mitsubishi Electric

Mitsubishi Electric supplies electronic parts within the Car & Platform-Centric use case as a device provider

Industry:	Automotive (Supplier)
Headquarter:	Tokyo, Japan
Employees:	124'035 (Mitsubishi Electric, 2015)
Revenue:	33.73 billion USD in 2014 (Mitsubishi Electric, 2015)
Global reach:	30 countries (Mitsubishi Electric, 2015)

Trafikverket

In the Environment-Centric use case, Trafikverket is a pilot partner and acts as a data customer (Interviewee[13], 2015).

Industry:	Public Sector (Road Authority)
Headquarter:	Borlänge, Sweden
Employees:	6'500 (Trafikverket, 2015)
Budget:	6.26 billion USD in 2014 (Trafikverket, 2015)

Cybercom Group

Within the Car & Platform-Centric use case, Cybercom Group is creating applications and sells know-how to project partners.

Industry:	Information Technology (Connectivity Solutions)
Headquarter:	Stockholm, Sweden
Employees:	1'222 (Cybercom Group, 2015)
Revenue:	150.34 million USD in 2014 (Cybercom Group, 2015)
Global reach:	7 countries (Cybercom Group, 2015)

Linas Matkasse

Linas Matkasse acts as a pilot partner in the Driver-Centric use case by providing ready to cook groceries on a subscription basis directly to the customer's homes once a week. The kind of menus, frequency and the volume depends on the kind of subscription bought (Linas Matkasse, 2015).

Industry:	E-Commerce (Groceries)
Headquarter:	Spanga, Sweden
Employees:	38 (Orbis, 2013)
Revenue:	67.9 million USD in 2013 (Orbis, 2013)
Global reach:	3+ countries (Interviewee[08], 2015)

Bring

Bring is acting as the logistic partner in the Driver-Centric use case.

Industry:	Logistics
Headquarter:	Oslo, Norway
Employees:	19'388 (Posten Norge, 2014)
Revenue:	3 billion USD in 2014 (Posten Norge, 2014)
Global reach:	15 countries (Posten Norge, 2014)
Notes:	Belongs to Posten Norge, from which the numbers above stem from.

Telenor Sweden

Telenor is the network provider for the platform around Volvo's Connected Car.

Industry:	Telecommunication (Network Provider)
Headquarter:	Fornebu, Norway
Employees:	33'220 (Telenor Group, 2011)
Revenue:	14 billion USD in 2014 (Telenor Group, 2015)
Global reach:	22 countries (Telenor Group, 2015)
Notes:	Belongs to Telenor Group, from which the numbers above stem from.

Telenor Connexion

Belonging to Telenor Digital within the Telenor Group, Telenor Connexion is providing information & communication services with focus on connectivity. They provide IT consulting services within the Car & Platform-Centric use case. For Telenor Group facts please see Chapter 5.1.9.

Nokia HERE

Nokia HERE is representative for content provider in general and acts as the map data provider in the Car & Platform-Centric use case.

Industry:	Data Provider (Navigation)
Headquarter:	Espoo, Finland
Employees:	6'067
Revenue:	1.09 billion USD in 2014 (Nokia, 2015)
Global reach:	140 countries (Telenor Group, 2015)

Appendix 5 – Overview Empirical Findings

Dimension	Car & Platform-Centric	Driver-Centric	Environment-Centric
General Collaboration	• Automotive lead times dictate collaboration primarily for hardware and fixed software solutions. Streamed content can be changed throughout the lifecycle • Use cases are considered OEM core business and have high strategic importance • Complexity of networks drives difficulty of collaboration. • Collaboration mainly on technical and operational level, not on strategic level.	• Collaboration is characterized by pilot setup with intention to learn and improve collaboration and monetize product. • No direct monetary results expected, primary short-term focus is to increase brand value.	• Primary benefits of the collaboration are to learn about the industry, how to monetize the data and use complementary capabilities • Sound business case and revenue stream is only of secondary importance
Setup & Framework	• Setup is a clear supplier – buyer relationship with strictly formalized procedures for all suppliers except content providers. This basically didn't change with the introduction of the Internet. • Content providers have a different setup mainly due to their size. • Organizational structure needs to be adopted cross-functionally and needs be anchored in the board roam • No clear setup for cross-supplier collaboration	• No clear setup structure. Rather try out pilot setup that can change throughout project. • Framework build on mutual trust and pilot is conducted on same hierarchical level. • Easy setup is important to not be too resource exhaustive for involved players. • New ways of working with ad-hoc problem solving and learning by doing are key. • Partners need to bring complementary capabilities. • Small innovative companies are advantageous to work with in innovation projects.	• Pilot project setup with limited scope focusing on MVP first. Mainly based on trust with no commercial obligation. • Different motives of actors, but mutual interest in the same data enables fruitful, explorative collaboration. • Cross-functional setup with focus on ad-hoc problem solving. • Data sharing disrupts traditional supplier relationship. Now reversed supplier relationship: OEM is data supplier. • Find partners to bring complimentary capabilities
Network Position	• OEM is focal actor. • OEM owns last mile towards the customer. Only exception is the network provided and some content provider with direct customer contracts. • Actor roles can change between life-cycles of a car • Cross-supplier collaboration is ad-hoc and mainly focusing on technical interface adjustments. Volvo is coordinating suppliers collaboration. • Network position of fixed build-in content provider and replaceable content provider needs to be differentiated	• Clear network positioning is not of primary importance for brand building pilot project. • Network positions are still not filled yet, since the business case for building a central infrastructure is not clear.	• Source of funding decides about project focus, effort and position power • Driver of project is the supplier of the product and data, that needs customer feedback on data quality • Actors are specializing on their core capabilities and outsource other required capabilities • Internal department decides about involvement and project focus and thereby about network position • Pilot project helps to early show pioneering role and improve positioning in greater ecosystem

Uncertainties	• Three main uncertainties:
	  • Demand uncertainty
	  • Technical uncertainty
	  • Business case uncertainty
	• Mainly OEM is exposed to demand uncertainty
	• Handling uncertainties mainly through benchmarking, organizational adjustments and close collaboration with supplier
		• Main uncertainties:
		  • Scalability of offerings to other markets
		  • Business case uncertainty
		  • Demand uncertainty
		  • Ecosystem constellation uncertainty
		  • Technical uncertainties
		  • Process and end result uncertainty
		  • Organizational uncertainties: how to handles new offerings with existing resources, structures & processes
		  • Organizational uncertainties: how to act like a startup within a big organization with established structures.
		• Handling uncertainties
		  • Keeping project small to increase speed & flexibility
		  • Trying out and learning by doing
		  • Executive sponsorship and persistence for organizational uncertainties
		  • Benchmarking with best practices
		  • Communication & networking
			• Main uncertainties:
			  • Scalability of offerings to other markets
			  • Ecosystem constellation uncertainty with unclear consequences
			  • Business case uncertainty
			  • Technical uncertainty
			  • Demand uncertainty
			• Handling uncertainties:
			  • Benchmarking and networking
			  • Cross functional organization setup
			  • Keeping project small to increase speed & flexibility

Other findings	• Shift from product to service imposes difficulties, especially for organizational culture to adopt. • Critical mass of connected vehicles is crucial. • Not the technology disrupts the industry, but rather the change in business models • Rising importance of IT in OEM product offerings	• Shift from product to services is evident and imposes difficulties. • Critical mass of connected vehicles is crucial. • Critical mass of offerings/ applications is necessary to make sense for the driver to purchase. • Strong clash between consumer electronics and automotive industry due to life cycles • Rising important of IT in OEM product offerings • Executive sponsorship is essential to for disruptive innovation within an organization.	• Shift from product to services creates advantages • Scalability of software products is new for automotive industry, but appreciated once hardware is in place • Data security is key

Table 7: Summary of Empirical Findings