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# **Digital Innovation: Orchestrating Network Activities**

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DOCTORAL DISSERTATION

## Abstract

Digitization of analogue everyday artifacts, i.e. when physical products are equipped with digital capabilities, has a profound impact on today's society. Some examples of these digital innovations aimed at consumer markets are the "connected" car, the digitized television set, and in the near future, digitized IKEA furniture. Digital innovation provides endless opportunities for providing value adding products and services. However, in digital innovation there is a need to find new ways of organizing network activities, i.e. activities such as e.g. production and translation of knowledge and enrollment of actors. These activities need to embrace and build on the networked aspects and the complexity inherent to digital innovation. This requires network activities that can overcome challenges with the ambiguous and messy characteristics of digital innovation. In this thesis, I propose that the theoretical perspective of *network orchestration* can enlighten fruitful ways to address challenges that are encountered when organizing network activities in digital innovation. Inspired by practical challenges with digital innovation, as well as contemporary calls for research within IS, this thesis investigates: *How can network activities be orchestrated in digital innovation?* Two cases of digital innovation aimed at consumer markets are studied. The first case concerns the digitization of the newspaper. The second case regards the digitization of door locks. Literature about digital innovation is used to understand the context of the studied phenomenon. Furthermore, theories about network orchestration as well as activities in innovation are used as a theoretical framework to help answer the research question. The thesis is based on an interpretative perspective where a multi-method approach has been applied to address the research question. The contribution is divided into two different parts. The first part presents four categories of empirically derived network activities that address socio-technical challenges with organizing digital innovation. The second part is a proposed model detailing orchestration of network activities in digital innovation. The model is based around the four suggested categories of network activities: (1) *Supporting flexible innovation networks*, (2) *Production and translation of layered architectural knowledge*, (3) *Addressing heterogeneous user communities*, and (4) *Harnessing generativity to leverage value*. The categories of network activities can be viewed as building blocks for the orchestration process. By emphasizing both a proactive and a reactive way of orchestrating digital innovation, the model proposes a means for organizations to address the ambiguity and complexity of digital innovation.

Keywords: digital innovation, network activities, orchestration, innovation network, Living Lab, digital technology

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To my wife Line, the love of my life, you make all things possible.

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# Table of Contents

1. Introduction .....	1
2. Digital Innovation .....	5
2.1 Digital Technology .....	6
2.1.1 The Modular and Layered Characteristic of Digital Technology .....	6
2.1.2 The Generative Characteristic of Digital Technology.....	7
2.2 Innovation Networks .....	9
2.2.1 Actors.....	10
2.2.2 Relationships.....	11
2.2.3 Knowledge Exchanges.....	12
3. Activities and Network Orchestration .....	14
3.1 Activities in Innovation .....	14
3.2 Orchestration of Innovation Networks.....	16
3.2.1 Network Design .....	17
3.2.2 Orchestration of Network Activities .....	18
3.3 A Conceptual Model of Network Activities in Digital Innovation .....	19
3.4 Socio-technical Challenges with Organizing Network Activities in Digital Innovation .....	19
3.4.1 Challenges derived from the Modular and Layered Characteristic of Digital Technology .....	20
3.4.2 Challenges derived from the Generative Characteristic of Digital Technology .....	20
4. Research Methodology .....	22
4.1 Philosophical Considerations.....	22
4.2 Empirical Cases.....	24
4.2.1 The DigiNews Case.....	24
4.2.2 The Smart Lock Case .....	25
4.3 Living Lab as Research Context.....	27
4.4 Research Design .....	30
4.5 Data Collection and Analysis .....	31
4.5.1 Data Collection in the DigiNews Case .....	31
4.5.2 Data Collection in the Smart Lock case.....	33
4.5.3 Data Analysis.....	34
4.6 Reflections on Research Process .....	36
5. Research Papers .....	39
5.1 Paper 1: Activities to Enable User Involvement in Innovation Networks.....	39
5.2 Paper 2: Actors Exchanges and Relationships .....	40
5.3 Paper 3: Socials Aspects Influence on Actors in Innovation Networks.....	41
5.4 Paper 4: Activities to Address Challenges in Digital Innovation .....	42
5.5 Paper 5: Interplay between Digital Technology and Innovation Network Dynamics .....	43
5.6 Related Research Papers .....	44
6. Research Contributions .....	46
6.1 Four Categories of Network Activities in Digital Innovation.....	46
6.1.1 Supporting Flexible Innovation Networks.....	46
6.1.2 Production and Translation of Layered Architectural Knowledge .....	48
6.1.3 Addressing Heterogeneous User Communities .....	50
6.1.4 Harnessing Generativity to Leverage Value.....	52
6.1.5 Summary: Network Activities in Digital Innovation .....	55
6.2 Orchestration of Network Activities in Digital Innovation.....	56

7. Conclusions .....	61
7.1 Implications for Research .....	61
7.2 Implications for Practice.....	61
7.3 Limitations and Future Research .....	62
References .....	64
PAPER 1: User Contribution in Innovation Processes - Reflections from a Living Lab Perspective .....	<b>Error! Bookmark not defined.</b>
PAPER 2: Facilitating Social and Cognitive Translation in Innovation Networks ..	<b>Error! Bookmark not defined.</b>
PAPER 3: Exploring Social Aspects Influence on Change in Network Relationships - a Case Study of Digital Innovation.....	<b>Error! Bookmark not defined.</b>
PAPER 4: Activities to Address Challenges in Digital Innovation .....	<b>Error! Bookmark not defined.</b>
PAPER 5: The Interplay between the Architecture of Digital Technology and Network Dynamics in Digital Innovation.....	<b>Error! Bookmark not defined.</b>

## 1. Introduction

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Digitalization, i.e. the adoption and socio-technical organization of digitized artifacts, has a profound impact on today's society. Even if the digitization of analogue everyday artifacts, i.e. when physical products are equipped with digital capabilities, has been a cumulative trend for a decade or more, the impact is truly evident today. Some examples of digitized everyday artifacts aimed at consumer markets are the "connected" car, the digitized television set, and in the near future, digitized IKEA furniture. These digital innovations provide new features such as media on demand and ubiquitous services available on multiple platforms.

Digital innovation is enabled by digital technology and digitization (Yoo et al., 2009) and refers to the embedding of digital computer and communication technology into a traditionally non-digital product (Henfridsson et al., 2009). Digital innovation differs from other forms of innovation primarily due to the architecture and the generativity of digital technology (Yoo et al., 2012; Yoo et al., 2010a; Tilson et al., 2010). The architecture is modular and multilayered and due to standardized interfaces between the layers, it is possible to combine and reconfigure components to create digital innovations (Yoo et al., 2010a; Kallinikos et al., 2013). This layered characteristic of digital technology enables generativity which creates unbounded opportunities and features for digital innovations (Zittrain, 2006; Yoo et al., 2012). However, the architecture and the generativity also create challenges for how to organize digital innovation processes (Yoo, 2010; Yoo et al., 2012; Svahn och Henfridsson, 2012).

Contemporary literature highlights the networked aspect of digital innovation where it is important, even necessary, to involve a wide set of heterogeneous actors (Tilson et al., 2010; Yoo et al., 2012; Eaton et al., 2015). However, this requires network activities that can handle the complexity related with digital innovation (Yoo et al., 2012), i.e. activities such as e.g. production and translation of knowledge and enrollment of actors (Pavitt, 2006; Dhanaraj and Parkhe, 2006). As different architectural layers of digital technology require different sets of knowledge, organizations typically need to collaborate to succeed with digital innovation (Andersson et al., 2008; Yoo et al., 2012; Kallinikos et al., 2013). These collaborations include finding new ways of combining different technologies as well as doing business in the digital landscape where business roles might rapidly change (Van de Ven, 2005; Yoo et al., 2005; Vanhaverbeke and Cloudt; 2006). In digital innovation there is a need to find new ways of organizing activities that embrace and build on the networked aspects inherent in digital innovation (Yoo, 2010; Tilson et al., 2010; Yoo et al., 2012; Svahn and Henfridsson, 2012).

The question of how to organize digital innovation has gained an increased interest among information system (IS) scholars. Two main topics can be discerned within the community. The first topic concerns heterogeneous actors in digital innovation as a result of the charac-

teristics of digital technology. This topic includes issues and challenges such as how to mobilize and involve actors in innovation networks who have different, and sometimes conflicting, interests and diverse knowledge bases (Yoo et al., 2009; Tilson et al., 2010; Eaton et al., 2015). The second topic concerns networked, complex and ambiguous digital innovation processes where generative, and malleable digital innovations are developed (Boland et al., 2007; Yoo 2010; Yoo et al., 2010a; Yoo et al., 2012; Thomsen and Åkesson, 2013).

Both topics are related to the networked aspect of digital innovation. Based on this, I have chosen to research this aspect further by investigating network activities in digital innovation. To create an understanding of activities in innovation networks, I have utilized innovation literature. According to this literature, innovation processes can be decomposed into different categories of activities (Van de Ven et al., 1999; Pavitt, 2006; Garud et al., 2013). These categories of activities are the building blocks of innovation. Furthermore, I propose that the theoretical perspective of *network orchestration* can enlighten fruitful ways to address challenges with organizing network activities in digital innovation.

Orchestration of network activities involves the way an actor coordinates, influences, and/or directs other actors in an innovation network (Nambisan and Sawhney, 2011). As such, network orchestration as a notion describes how one or more actors designs the network, and initiates and leverages the dispersed resources and capabilities of the involved actors (Dhanaraj and Parkhe, 2006; Levén et al., 2014). Additionally, network orchestration deals with how activities are initiated, stimulated and unfolded within an innovation network (Levén et al., 2014). Such network activities include the support of e.g. knowledge mobility, innovation appropriability and network stability (Dhanaraj and Parkhe, 2006).

Research concerning the organization of network activities in digital innovation is argued to be valuable for IS scholarship, as well as for practitioners who need to address the complexity of digital innovation (Yoo, 2010; Tiwana et al. 2010; Tilson et al., 2010; Yoo et al., 2012). Examples of questions asked are (Yoo, 2010): how can organizations manage networked and nonlinear activities in digital innovation, and how can organizations manage the heterogeneity of required knowledge resources in producing new digital products and services leveraging user and consumer value? A better understanding of this can help scholars, as well as practitioners, to understand how network activities can be orchestrated to support digital innovation.

Therefore, inspired by practical challenges with digital innovation, as well as contemporary calls for research within IS, this thesis is guided by the research question:

***How can network activities be orchestrated in digital innovation?***

In this thesis, two cases of digitization of everyday artifacts are studied. One case concerns the digitization of the traditional newspaper into a digital newspaper service launched on an e-paper device. The other case concerns the digitization of a door lock. Common to these cases was that they both involved technologies that were dependent on the use of hardware



platforms (reading device and lock) that were digitized, and as a part of this process new digital services were created. A key challenge in these cases of digital innovation was to successfully organize and manage the different ongoing network activities. Examples of activities which had to be managed in this setting concerned establishing and sustaining relationships between actors from different fields into inter-organizational innovation networks. In these networks, actors with different and sometimes conflicting interests and agendas had to successfully collaborate to implement digital innovations which provided value for all involved actors as well as leveraging user and consumer value. This included orchestrating network activities which supported and facilitated knowledge exchanges between highly diverse actors. Other network activities concerned the involvement of heterogeneous user and consumer communities to identify and leverage value with the digital innovations at hand.

A multi method approach (Mingers, 2001), was adopted to address the research question. Inspired by Mingers (2001) and Walsham (2006), I have combined several data collection methods within the two cases of digital innovation in order to gain a deeper understanding of the studied research phenomenon. The context of study has been innovation networks in digital innovation. An innovation network in digital innovation can be defined as an adaptive, open, distributed, and socio-technical network. It can be seen as a collective of actors spanning organizational and market boundaries, which are interlinked by interests relating to the implementation of a digital innovation (Selander et al., 2013). The actors involved in an innovation network have different relationships and exchange knowledge necessary for the digital innovation at hand.

My object of study in these innovation networks is orchestration of network activities. An activity is something that actors do to obtain a desired outcome. In an innovation context, activities can be categorized into three categories which overlap each other or occur parallel to one another (Pavitt, 2006): a) production of knowledge, b) translation of knowledge, c) responding to market demand. Network orchestration can be defined as the subtle leadership of coordinating and facilitating interaction between heterogeneous actors in an innovation network (Levén et al., 2014; Nambisan and Sawhney, 2011). This includes deliberate and purposeful network activities orchestrated by a firm with the goal of creating and extracting value from an innovation network (Dhanaraj and Parkhe, 2006). Network orchestration can be divided into two different parts (Dhanaraj and Parkhe, 2006; Levén et al., 2014). The first part deals with how an innovation network is designed. The second part concerns how activities within the innovation network are initiated, organized and stimulated.

The thesis utilizes three different bases of literature to support the study. Literature about digital innovation, including a body of knowledge concerning digital technology, digital infrastructures and innovation networks, is used to understand the context of the studied phenomenon. Furthermore, theories about activities in innovation as well as network orchestration are used as a theoretical framework to help answer the research question.

## COVER PAPER

The thesis is based on a cover paper and a collection of five individual papers. The cover paper is structured as follows. Section 2 highlights literature regarding digital innovation. In section 3, the theoretical framework is presented. Section 3 ends with a presentation of socio-technical challenges relating to orchestration of network activities in digital innovation deduced from the literature. The research method is presented in section 4 together with a description of the two cases and Living Lab as the research context. Section 5 explains the individual contributions of the five papers, whereas section 6 presents the main contribution of the cover paper. The contribution is divided into two different parts. The first part presents four categories of empirically derived network activities that address socio-technical challenges with organizing digital innovation. The second part is a proposed model detailing orchestration of network activities in digital innovation. Finally, the concluding remarks are presented in section 7 along with limitations and suggestions of future research. Following the cover paper is the collection of the five individual papers. These papers are presented below in the same order which they will be referred to in the cover paper.

**Paper 1:** Svensson, J., Ihlström Eriksson, C., and Ebbesson, E. (2010). User Contribution in Innovation Processes - Reflections from a Living Lab Perspective. In Proceedings of HICSS'43, Kauai, Hawaii, January 5-8.

**Paper 2:** Svensson, J., and Ebbesson, E. (2010). Facilitating Social and Cognitive Translation in Innovation Networks. In Proceedings of MCIS 2010, Tel Aviv, Israel, September 12-14.

**Paper 3:** Svensson, J. and Ihlström Eriksson, C. (2012). Exploring Social Aspects Influence on Change in Network Relationships - a Case Study of Digital Innovation, International Journal of Social and Organizational Dynamics in IT 2(4), pp. 14-33.

**Paper 4:** Lund, J. (2014). Activities to Address Challenges in Digital Innovation. Proceedings of IFIP WG 8.2: Information Systems and Global Assemblages: (Re)Configuring Actors, Artefacts, Organizations. Auckland, New Zealand, December 11-12, 2014.

**Paper 5:** Lund, J., and Ebbesson, E. The Interplay between the Architecture of Digital Technology and Network Dynamics in Digital Innovation. To be revised and re-submitted to a third round of reviewing to Scandinavian Journal of Information Systems.

## 2. Digital Innovation

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Innovation has long been a central theme for the Information Systems (IS) field. Innovation can be defined as an idea, practice, or object that is perceived to be new by an adopting unit. The term innovation also refers to the process where new ideas, practices and objects are created and developed (Zaltman et al., 1973). From a process perspective, innovation can be defined as the invention, development, and implementation of new ideas (Garud et al., 2013). Innovation is often described to involve design and development, adoption, and diffusion (Slappendel, 1996). Traditionally, the main interest of innovation within the IS field has been regarding how organizations successfully adopt IT innovations and how these can act as drivers of organizational and business development (Swanson, 1994; Lyytinen and Rose, 2003). Today, the field of innovation in IS extends beyond the organizational realm into consumer and end user markets (Lyytinen and Yoo, 2002; Yoo, 2010; Walsham, 2012).

The traditional way of innovating is to use internal research and development (R&D) to enhance existing products and services and to generate new potential ideas (Chesbrough et al., 2006). However, in many consumer markets of today, this approach is no longer sufficient. Knowledge sources outside a formal R&D department have become more and more important in innovation (Cohen and Levinthal, 1990; Westergren and Holmström, 2012). Instead of mainly relying on internal sources of innovation, Chesbrough (2003) suggests an open innovation approach where innovation relies on both internal and external resources for ideas, development of innovation, and business model generation. By opening up innovation, more firms in the supply or value chain start to play an increasingly important role. This also creates opportunities for exploiting new markets (Chesbrough, 2003).

A way of generating ideas and innovation is to involve users or consumers in innovation processes. Open innovation can be used as one example of involving not only external firms and organizations in innovation, but also consumer communities. User driven innovation is another example where the involvement of consumers as end users in innovation is highlighted (Thomke and von Hippel, 2002). Users can be the source of innovation and user involvement could therefore be of vital part in innovation processes (von Hippel, 1988; Von Hippel, 2005; Thomke and von Hippel, 2002).

Open and user driven innovation are two examples of how the view of innovation has evolved over the last three decades. Both approaches have been of interest within the IS field (see e.g. Nambisan et al., 1999; Han et al., 2012). Another current stream of innovation studies within the IS community concerns digital innovation. Digital innovation refers to the embedding of digital computer and communication technology into a traditionally non-digital product (Henfridsson et al., 2009). Digital innovation also refers to the process of creating new combinations of digital and physical components that produce novel digital products or services (Yoo et al., 2010a).

Digital innovation as a process is often described to be a networked achievement involving many actors, including user communities, often with different interests and intentions (Yoo et al., 2005; Van de Ven, 2005; Kallinikos et al., 2013). The network activities typically include heterogeneous actors from different fields with diverse knowledge bases (Powell and Grodal, 2006; Yoo et al., 2009; Yoo et al., 2012). As a result, actors with heterogeneous knowledge that spans over organizational borders need to collaborate in order to successfully innovate. The networked aspects of digital innovation therefore drive a need for collaborations crossing organizational realms (Andersson et al., 2008; Yoo et al., 2010a; Tiwana et al., 2010). These heterogeneous knowledge bases fuel innovation capacity (Simard and West, 2006). However, the heterogeneity is also challenging the innovation processes when knowledge needs to be exchanged over interorganizational boundaries (Van de Ven et al., 1999; Simard and West, 2006; Lindgren et al., 2008).

## **2.1 Digital Technology**

Digital innovation as an artifact is enabled by digital technology. Digital technology can be configured and adapted to support more or less every aspect of work and everyday life (Yoo, 2010). Digital technology is often described to drive convergence (Yoo et al., 2012; Yoo et al., 2010a). The convergence of media and products brings together previously separate industries (Yoffie, 1997). For example, smart television sets and smartphones enable multiple new service opportunities on one single device with applications easily accessible via digital marketplaces (Yoo et al., 2012). Another example is the book publishing industry and the consumer electronic industry which collaborated to create and launch the Amazon Kindle, a digital (also called electronic) book.

In the following two subsections two specific characteristics of digital technology is presented. The first subsection presents the modular and layered characteristic of digital technology. The second subsection presents the generative characteristic of digital technology.

### **2.1.1 The Modular and Layered Characteristic of Digital Technology**

To illustrate the configurable nature of digital technology the notion of modularity and layers can be used. Modularity refers to the degree to which a product or a platform can be decomposed into components (Yoo et al., 2010a). Modularity is enabled by standardized interfaces. These interfaces make flexible products and platforms possible by enabling components to be re-combined to create new features and functionality (Baldwin and Woodard, 2009; Yoo et al., 2010a). As such, the specified and standardized interfaces allows for interoperability in products and platforms (Baldwin and Woodard, 2009). Examples of these interfaces in digital technology are software development kits (SDK), application programming interfaces (API), the basic input/output system (BIOS) of a computer, and the TCP/IP protocol. These standardized interfaces allow software and hardware components, as well as services and content components, to be combined in different ways in different architectural layers of the digital technology.

One way of separating digital technology is based on the division of physical, logical, and content layers (Benkler, 2006). The physical layer refers to transmission channels and devices for communicating and producing information. Computers, smartphones, and wireless links are examples of physical layers. The logical layer concerns standards and algorithms that translate meaning into transmittable, storable or computable data. This layer includes protocols, standards, and software such as operating systems and applications. Finally, the content layer relates to data which is meaningful for human communication. In digitally mediated human communications, all three layers are used (Benkler, 2006).

Another way of dividing layered digital technology is based on four layers: device, network, service, and contents (Yoo et al., 2010a). These layers enable two important separations: the separation between service and device due to re-programmability, and the separation between contents and networks due to homogenization of data (Yoo et al., 2010a). The re-programmability enables digital devices to support wide arrays of functions, everything from complex calculations in niche applications, to word processing and web browsing. The homogenization of data allows digital content such as images, video, and audio to be displayed, processed, transmitted and stored on almost any digital device.

Layered digital technology is an example of a modular architecture which enables independent firms to launch innovations into established markets. For example, independent app developers can use Apple and Android app stores and marketplaces to launch their applications on a multitude of different devices. As a result of the modular architecture of digital technology, designers can combine components from different layers (Tiwana et al., 2010). The modularity enables new digital innovations where the best actors in each of the layers can be involved and innovate (Farell and Weiser, 2003). Design decisions for components in each of the architectural layers can be made with small considerations of other layers. The modularity therefore increases flexibility in a design by enabling a decomposition of the architecture into separate components (Yoo et al., 2010a; Henfridsson et al., 2014).

While the layers enable digital innovation, different actors from different fields are often required to cooperate. As different layers of digital technology require different knowledge, competencies and resources, organizations often need to come together in heterogeneous innovation networks in order to be able to succeed with digital innovation (Tilson et al., 2010; Yoo et al., 2012; Kallinikos et al., 2013). As a result, digital innovation as a process becomes networked and complex (Boland et al., 2007; Yoo et al., 2010a, Yoo et al., 2012 ; Tiwana et al., 2010).

### **2.1.2 The Generative Characteristic of Digital Technology**

There are at least two different perspectives of generativity as a notion. The first perspective is that generativity can be the ability of individuals or an organization to innovate and generate new functions and features for products and services (see e.g. Avital and Teéni, 2009; Austin et al., 2012). The second perspective, which is used in this thesis, considers generativity as a characteristic of digital technology. This perspective, founded in the work by Zittrain

(2006), denotes generativity as “a technology’s overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences” (p. 1980). Generativity as a characteristic of digital technology means that digital innovations based on said technology become inherently malleable and dynamic. Furthermore, generativity typically leads to new and unanticipated digital innovations as spin off effects of existing usage of digital technology (Yoo et al., 2012).

The modular layered architecture of digital technology produces unprecedented levels of generativity (Zittrain, 2006; Yoo et al., 2012; Eaton et al., 2015). The generativity is enabled by the modularity across the architectural layers of digital technology. This creates opportunities for new innovation and features at all four architectural layers. Generativity allows for constantly new variations of digital technology resulting in new digital innovations (Boland et al., 2007; Yoo et al., 2010a; Tilson et al., 2010). As a result, generativity creates unbounded opportunities for innovating digital products and services (Zittrain, 2006; Boland et al., 2007; Yoo et al., 2010a; Tilson et al., 2010).

Generativity can also be related to the ability to add new functionality and capabilities after a product is launched on a market (Zittrain, 2006; Yoo et al., 2010a; Yoo et al., 2012). This can be exemplified with today’s smartphones. The smartphones in this case act as platforms for applications, which make the technology adaptable and changeable based on consumers’ needs. The personal computer is another example of a product based on adaptable digital technology. Applications turn smartphones and PC’s into adaptable and changeable digital tools which support a very wide variety of users and aspects of use. Therefore, generativity of digital technology leads to large and varied user and consumer communities (Zittrain, 2006; Yoo et al., 2010a; Yoo et al., 2012).

The characteristics of digital technology are blurring organizational boundaries (Yoo et al., 2012; Kallinikos et al., 2013). As a result new sociotechnical relationships are created to ideate, develop and implement digital innovations. These novel sociotechnical relationships are challenging the orchestration of network activities in digital innovation as they typically requires a digital ecosystem or network to handle issues relating to change and control (Wareham et al., 2014; Tilson et al., 2010; Ghazawneh and Henfridsson, 2013). An innovation network in digital innovation needs to be both stable and flexible as well as offering control and autonomy. These dualities can be described as paradoxical in digital innovation (Tilson et al., 2010). Network activities therefore need to be orchestrated to handle the implications of generativity on innovation networks and the digital innovations at hand. As such, the activities need to support changes created by the generativity. This includes changes in the sociotechnical relationships, e.g. bringing new actors into the innovation networks (i.e. support flexibility) and handling issues with control and value creation between existing actors (i.e. support stability).

## 2.2 Innovation Networks

As digital innovation is networked and distributed, activities typically take place in innovation networks (Boland et al., 2007; Tiwana et al., 2010; Yoo et al., 2012). An innovation network in digital innovation can be defined as a collection of actors spanning organizational and market boundaries, which are interlinked by interests relating to the implementation of an innovation based on digital technology (Selander et al., 2013). These are temporary networks where activities take place with the specific aim to innovate, develop, and implement a digital innovation (Powell and Grodal, 2006; Garud et al., 2013). In an innovation network, firms co-evolve capabilities related to a new innovation (Powell and Grodal, 2006; Yoffie, 1997). This allows firms to create value that no single firm can create alone (Adner, 2006). The actors involved both cooperate and compete to support new innovations in order to meet customer needs (Moore, 1993). An innovation network in digital innovation is therefore typically an open, adaptive, distributed, and socio-technical network where actors with different relationships and exchanges have the opportunity to innovate, develop, and implement digital innovations via network activities.

Innovation networks can either be based on formal or informal relationships. Examples of formal networks are strategic alliances, networks of subcontractors, and research consortiums. Examples of informal networks could be trade associations or different kinds of technological communities. Innovation networks can be defined by their stability and duration which discerns four different types of networks (Powell and Grodal, 2006). The first type is informal networks which are normally based on shared experiences. The second type is project networks which are short-term constellations that aim to accomplish specific tasks. The third type is regional networks in which the geographical distribution of actors sustains the network. Finally, the fourth type is business networks which are normally strategic alliances with a specific purpose. The different types of networks may overlap each other and are therefore not considered as archetypes (Powell and Grodal, 2006).

Within several technological and knowledge intense fields there has been a shift from actors that innovate with internal sources to networks of actors innovating together. The traditional vertical integration model that has been adopted by actors in computer and consumer electronic industries is being replaced by a horizontal model more and more frequently (Moore, 1993; Yoffie, 1997). In a vertical integration model, formerly used by companies such as IBM or Fujitsu, most components and software was developed in-house. The firms sold a complete package to their customers with e.g. custom developed software and hardware. The vertical model was made possible due to the proprietary of computer components and software, something that made "closed" products viable. However, in a horizontal model, due to growing scale economies, actors aim for large and dominant market shares by specialization (Yoffie, 1997). These actors normally focus on building very specialized and distinctive competencies and then become a node in an innovation or a value network. For example, in the computer industry this could mean that an actor focuses on developing either hardware or software, not both.

Another reason for individual actors, such as firms or organizations, to align themselves in innovation networks is that there are difficulties innovating and launching new complex technological innovations alone (Van de Ven, 2005; Wareham et al., 2014). To profit from technological innovation, diverse resources and knowledge sets are typically important (Teece, 1986). Innovation networks therefore often consist of actors who provide complementary knowledge to an innovation.

Innovation networks and value networks are closely related. Innovation networks primarily relate to research and development of an innovation whereas value networks relate to the realization and commercialization of the values connected to the innovation (Vanhaverbeke and Cloudt, 2006). Value network configuration can be described by having both a mobilizing and a stabilizing movement (Åkesson, 2009). The mobilizing movement relates to behavior of e.g. mobilizing new customer bases, new market knowledge, or mobilizing relationships to new external actors. Stabilizing movement relates to behavior of e.g. centralizing control, standardizing business model structure, defining customer bases, formalizing and deepening relationships and aligning interests with relevant actors.

The following three subsections present more detailed descriptions concerning innovation actors, innovation network relationships, and innovation network exchanges.

### **2.2.1 Actors**

Most innovations require a wide set of different actors involved in an innovation network (Van de Ven et al., 1999). In digital innovation aimed at consumer markets, it is important to involve actors such as firms and business organizations, user and consumer communities, academia, and public organizations (Eriksson et al., 2005). By setting up an innovation network with actors from different backgrounds, with different perspectives, possessing different knowledge, assets and experiences, creativity is boosted (Yoffie, 1997; Chesbrough et al., 2006; Tiwana et al., 2010). This creates a good ground for generating new ideas which can be turned into innovation and bring value through use (Powell and Grodal, 2006; Eriksson et al., 2005). In digital innovation the collaborating actors often have diverse and heterogeneous sets of knowledge. As a response to the knowledge intense and networked aspects of digital innovation, actors are often highly dependent on each other's knowledge (Vanhaverbeke and Cloudt, 2006).

Another example of heterogeneity in digital innovation relates to the users (Yoo, 2010). Digital technology targeted against everyday use inherently leads to a change in how the user is viewed. The notion of "users" needs to be expanded beyond users as organizational members. With digitization of everyday artifacts, users do not solely use computing capabilities for work or organizational purposes; they interact with digital technology in much broader social contexts (Yoo, 2010). The example of smartphones can again be used to illustrate this. Today smartphones are used by a very large and diverse consumer audience with heterogeneous needs. People of all ages and social groups use smartphones. As a result, user needs and requirements often become heterogeneous in digital innovation use contexts (Hen-



fridsson and Lindgren, 2010; Yoo, 2010). A way to address heterogeneous user needs and requirements is to actively involve users in digital innovation. Users can often be a source of innovation and user involvement can therefore be important in network activities (von Hippel, 2005; Thomke and von Hippel, 2002).

Even if users as actors have gained an increased interest in innovation literature, firms are the primary focal point for innovation scholars. In relation to firms as actors in network activities, absorptive capacity is often highlighted. The ability of a firm to identify the value of external knowledge, and then assimilate and apply it, is a crucial part of its innovation capacity (Cohen and Levinthal, 1990). This absorptive capacity is suggested to strongly relate to an organization's level of prior knowledge. A firm's absorptive capacity is essential to enable knowledge exchange between actors in networks (Garud et al., 2013). The absorptive capacity for actors in networks is strengthened if the actors have similar knowledge backgrounds and product portfolios (Mowery et al., 1996). Therefore, absorptive capacity could be a barrier for knowledge exchange in heterogeneous innovation networks that include actors with diverse knowledge backgrounds (Garud et al., 2013).

### **2.2.2 Relationships**

Innovating in an innovation network setting can be characterized as series of social interactions (Yoo, 2010). The social aspect is a byproduct of the negotiations between actors when they obtain, transform, and share knowledge. The negotiations influence actors' identities and their relationships to others, which are constantly being re-defined during network activities (Yoo et al., 2010a, p. 10). The social interactions can be described as series of negotiations of interests between actors. During these negotiations actors iteratively influence the behavior of each other (Yoo et al., 2009). These social interactions are characterized by the on-going shaping and re-shaping of actors' roles and relationships in an innovation network.

In innovation networks, trading zones between actors can be established (Yoo et al., 2009). These trading zones enable different actors, with different knowledge bases and agendas, to collaborate, negotiate, and learn from each other (Boland et al., 2007). Trading zones can allow very distinct knowledge to be exchanged between actors. An established trading zone also enables coproduction of new knowledge. Trading zones can therefore be described as both cognitive and physical arenas where communities with their own agendas, knowledge, and innovation trajectories, meet to negotiate, collaborate and learn from one another (Boland et al., 2007). The continuous negotiation of interests and the interplay between actors creates the foundation which supports alignment of perspectives and interests. This alignment is vital for successful relationships between heterogeneous actors in innovation networks (Powell and Grodal, 2006; Yoo et al., 2009). A lack of alignment of interest may often result in unsuccessful innovation implementations. Previously unconnected actors are inherently difficult to coordinate and mobilize around novel ideas. Therefore, even if new ideas emerge and the innovation capacity is strengthened by heterogeneous actors, this capacity cannot be reaped unless the actors interests are aligned (Obstfeld, 2005; Ahuja, 2000).

Activities in digital innovation that occur in innovation networks of heterogeneous actors are messy and complex (Tiwana et al. 2010; Tilson et al., 2010; Yoo et al., 2012). These network activities differ somewhat from other forms of innovation. This is due to interactions between actors that continuously change relationships and social orders. Especially in fields of technological uncertainty, firms are likely to look for other actors outside their own organizational boundaries to involve in an innovation network (Andersson et al., 2008; Yoo et al., 2009). One explanation to this is that actors can share the resources needed for developing innovative technology by forming innovation networks. Therefore, they can also share risks. Innovation networks often provide access to various sources of knowledge, resources, and assets. The interaction between actors in an innovation network also increases individual actors' innovation capacity. This is especially evident in small and young organizations which generally benefit more from the interactions and relationships in an innovation network compared to larger firms. Successful external relationships therefore fuel innovation and growth within an organization (Powell and Grodal, 2006).

### **2.2.3 Knowledge Exchanges**

Innovating technological products and services, such as digital innovations, is typically a collective effort. Actors involved in such innovations can be seen as part of an innovation network that creates and shares knowledge. Knowledge, as well as complementary assets needed for technological innovations, is therefore seldom enclosed in a single firm or organization (Van de Ven, 2005). Therefore, one driving force for actors coming together in an innovation network is the need for different exchanges (Westergren and Holmström, 2012). In innovation networks, actors exchange knowledge, resources, and assets. Knowledge exchange within organizations, or between organizations, is specifically identified as an important aspect to enable and improve innovation capacity (Van de Ven et al., 1999; Chesbrough, 2003; Powell and Grodal, 2006).

Knowledge exchange in innovation networks requires the ability for involved actors to utilize their own knowledge, while concurrently taking perspectives of other actors into account (Boland and Tenkasi, 1995). This 'perspective making' can be described as a series of steps where actors make their own knowledge domain and practices visible in an innovation network. 'Perspective taking' on the other hand can be described as an evaluation and integration of knowledge that other actors possess. To exchange knowledge between actors in an innovation network, it has to be made accessible. This can be done, for example, by using representations or narratives (specifications, prototypes etc.). These representations or narratives enable actors to engage in network activities where they explore, acknowledge, and appropriate other actors' knowledge, and at the same time making their own knowledge accessible (Boland and Tenkasi, 1995; Carlile, 2002; Garud et al., 2013).

The importance of knowledge exchange between different actors is particularly recognizable in network activities involving development in leading edge technologies (Powell and Grodal, 2006). In this setting actors strive to find creative ways to represent and integrate the

knowledge they have between each other (Boland and Tenkasi, 1995; Lindgren et al., 2008; Andersson et al., 2008). Representations or narratives that integrate knowledge can be described as boundary objects that act as mediators between different actors with different knowledge basis. An example of boundary objects, which bridge communities of knowledge, is computer-aided design (CAD) output which consists of three-dimensional representations. These boundary objects have been shown to bridge communities of knowledge in architecture, engineering and construction (Boland et al., 2007).

By increasing the variety of boundary objects used for knowledge exchanges between actors, the accuracy, range and nature of knowledge exchanges can be improved (Carlile, 2002). Even so, it is still challenging to negotiate and make sense of unique knowledge brought in by diverse actors with different knowledge backgrounds. Knowledge exchanges leading forward towards a final innovation outcome rarely form a linear process, instead it can typically be characterized as iterative, fractal and messy (Boland et al., 2007; Yoo et al., 2009). If one can find new ways of connecting, translating, and exchanging knowledge between heterogeneous actors, innovation will have a higher chance to occur (Andersson et al., 2008; Yoo et al., 2009).

### 3. Activities and Network Orchestration

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An activity can be defined as a form of doing directed at an object, where the objects distinguish activities from each other (Kuutti, 1996). Objects can be both tangible and intangible and ranging from e.g. a piece of digital technology, to a plan, a vision, or a common idea. As long as it is possible to share said object between actors and it can be transformed and manipulated by all involved actors, it can be classified as an object. The main motive of an activity is to transform an object into an outcome (Kuutti, 1996). In digital innovation this can be to transform a vision of a digital artifact into the actual digital product or service. This typically involves connected and intertwined activities with one or more actors involved. Connected activities with different objects might result in tensions and conflicting motives which can both hinder, but also act as a source for innovation (Engeström, 2001). An object is often transformed into an outcome via a process which consists of different actions, or a chain of actions connected to each other by the same object and motive. Therefore, an activity can be described as performing conscious actions with a defined goal (Kuutti, 1996).

#### 3.1 Activities in Innovation

Innovation can be seen from several different perspectives. For example, an evolutionary perspective is based on variation, selection, and retention. Variation concerns the emergence of novel ideas. Selection concerns the removal of those ideas that are unfit. Finally, retention concerns practices developing the ideas that remain (Garud et al., 2013). Another perspective is based on a linear model of innovation. Examples of linear models are the technology-push and the need-pull models. In the first model, development, production and marketing of new technology follows a fixed linear sequence. First, basic and applied research is conducted, followed by product development and lastly production and commercialization. In the need-pull model, market demand is the main source of ideas for R&D (Fischer, 2006; Garud et al., 2013).

Today, many innovation models are based on an interaction perspective (Rothwell, 1994; Garud et al., 2013). These models are based on the chain-linked model formed from feedback loops between technology and market related phases of innovation (Kline and Rosenberg, 1986). Disregarding perspectives, most innovation scholars agree that innovation and knowledge are closely tied together (Van de Ven et al., 1999; Rogers, 2003; Fischer, 2006). It involves the utilization of new knowledge into innovation or a combination of existing knowledge (OECD/Eurostat, 2005). From a knowledge perspective, network activities can be described as very dynamic in which knowledge is accumulated through interaction and learning between actors (Garud et al., 2013). New knowledge may either be generated by the innovating actor, or acquired externally. The generation of knowledge typically occurs in relation to R&D, whereas acquisition of knowledge might be done by e.g. purchasing patents to get access to knowledge (Rogers, 2003). Appropriating new knowledge into innovations, or to combine existing knowledge in new ways, normally demands processes which can be distinguished from standardized development processes (OECD/Eurostat, 2005).

Activities in innovation can be divided into three different phases. These phases consist of a) invention; the generation of an idea, b) development; the elaboration of an idea, and c) implementation; the diffusion and acceptance of an innovation (Van de Ven et al., 1999; Garud et al., 2013). Activities aiming at developing technological innovations are often messy and complex (Van de Ven et al., 1999; Powell and Grodal, 2006; Garud et al., 2013). A reason for this messiness and complexity is because innovation is not linear, but instead actors and artifacts are entangled in several concurrent activities (Garud et al., 2013). Involved actor roles are often transformed during the development of an innovation, primarily due to changes in resources needed to develop the innovation. All in all, the innovation vision itself is typically transformed as the innovation evolves (Van de Ven et al., 1999; Garud et al., 2013).

This is also typical for network activities in digital innovation where heterogeneous actors with different sets of knowledge, resources, and assets interact (Boland et al., 2007; Yoo et al., 2009; Yoo, 2010; Yoo et al., 2012). Ambiguity is another aspect of digital innovation that drives complexity. As digital innovation takes place in emergent design domains based on emergent design solutions, they become ambiguous. As emergent properties are not predictable and definable in the start of an innovation process, it becomes challenging to plan, manage, and evaluate the outcome of activities in innovation (Thomsen and Åkesson, 2013). The ambiguity of innovation often also means that “wicked problems” need to be handled. These problems are characterized by ill-defined use contexts, unstable requirements, malleable artifacts and processes, and critical dependencies of the actors’ creativity and social abilities to produce effective solutions to the problems (Hevner et al., 2004; Stolterman, 2008). The ambiguous, complex, heterogeneous, and networked features of activities in digital innovation are a challenge that needs to be addressed by IS scholars (Tilson et al., 2010; Yoo et al., 2010b; Svahn and Henfridsson, 2012; Yoo et al., 2012; Eaton et al., 2015).

Involving consumers and end-users in innovation has gained an increased interest within innovation research (Von Hippel, 2005; Garud et al., 2013). As new product ideas often come from users or consumers themselves, user involvement in innovation is important (Von Hippel, 1988; Van de Ven et al., 1999). However, to unleash the potential of users’ creativity, one needs to be able to motivate and enable individuals to innovate (Van de Ven et al., 1999). User involvement in innovation can be divided into three different kinds of user contribution; a) decision, b) information and c) creation (Reichwald et al., 2004). In decision activities users are able to decide or evaluate tangible prototypes or given facts. This can be done via e.g. closed-questionnaire surveys or online voting. In information activities users are able to express their needs, requirements, or preferences. This can be done via e.g. focus groups, idea competitions, and feedback hotlines. Finally, in creation activities the users are able to be creative by becoming co-designers of a product or service. This can be done via e.g. user toolkits, mock-ups, or prototypes built by the users themselves (Reichwald et al., 2004).

Activities in innovation are difficult to generalize due to the contingent nature of innovation (Van de Ven et al., 1999). Even so, innovation can be divided into three categories of activities which often overlap each other or occur in parallel (Pavitt, 2006). The first category concerns the *production of knowledge* where actors become increasingly specialized by their production of scientific or technological knowledge. The second category concerns the *translation of knowledge into working artifacts*. As the complexity grows in technological artifacts, the knowledge needed to realize them also becomes more complex (Pavitt, 2006). Finally, the third category concerns *responding to and influencing market demand* which involves how one can match developed artifacts with consumers' requirements and market demands and needs.

### **3.2 Orchestration of Innovation Networks**

Network orchestration as a theoretical notion is used to describe the organization of activities in networked innovation contexts (Busquets, 2010; Nambisan and Sawhney, 2011; Hurmelinna-Laukkanen et al., 2012). Network orchestration also concerns the subtle leadership of a hub actor who facilitates relationships and exchanges between independent actors of an innovation network (Levén et al., 2014). Innovation networks typically contain dynamic relationships between actors where one or more actors influence, coordinate, and/or direct other actors by orchestrating network activities (Dhanaraj and Parkhe 2006; Nambisan and Sawhney, 2011). Orchestration is argued to be a critical capacity in networked innovation as it creates a purposive set of activities which forms an innovation path that ensures value for the involved actors (Busquets, 2010).

Network orchestration within the field of innovation most often refers to the seminal work done by Dhanaraj and Parkhe (2006). Their management theory, concerning design and orchestration of innovation networks, has previously been used by IS scholars as an analytical framework to study orchestration of innovation in networks (e.g. Busquets, 2010; Hjalmarsson and Lind, 2011; Levén et al., 2014). However, these studies lack a focus on the specific network activities that are conducted. Furthermore, these studies do not elaborate on the interrelationship between network activities or the fundamental logic of the orchestration process. Finally, none of these studies are done on digital innovation.

The theoretical framework presented by Dhanaraj and Parkhe (2006) focuses on how a hub actor orchestrates network activities, and how these activities relate to the innovation outcome. The framework highlights two different processes, a network recruitment process leading to the *network design*, and an *orchestration process* of network activities. The orchestration of network activities results in the network output, i.e. the outcome of the process. If the orchestration process is successful, new innovations, or modifications of existing ones, will be the outcome. The framework places the most emphasis on the orchestration process. As such, the framework helps explain how a hub actor can facilitate relationships and exchanges between actors in an innovation network to improve the innovation outcome. Even if the framework does not focus on the network design, it still highlights the im-

portant relationship between the innovation network and the orchestration of network activities.

Dhanaraj and Parkhe (2006) define network orchestration as the set of deliberate and purposeful activities orchestrated by a hub firm with the goal of creating and extracting value from a network. For an innovation network to be attractive for actors, value must be created and extracted. The hub actor has an important role in this by influencing two important parts of an innovation network. Firstly, the hub actor influences the initiation and the design of the network, thereby facilitating relationships which enable exchanges of dispersed and distributed resources and capabilities of network actors. Secondly, as an orchestrator, a hub actor can influence how network activities are both established and supported with the help of deliberate and purposeful actions (Dhanaraj and Parkhe, 2006). In the following subsections, more detailed descriptions are presented regarding network design as well as orchestration of network activities.

### **3.2.1 Network Design**

There are three structural variables to network design according to Dhanaraj and Parkhe (2006): membership, structure, and position.

*Network membership* is about the size and diversity of the network. If knowledge is accessible and transferable between actors, a large and diverse innovation network of heterogeneous actors typically means a high knowledge and innovation potential (Van de Ven et al., 1999; Chesbrough, 2003; Powell and Grodal, 2006; Simard and West, 2006). A hub actor can influence the network membership through, for example, different recruitment activities. These activities include learning about possible value constellations by involving new actors, or by making existing actors aware of benefits and possibilities with a network membership (Levén et al., 2014).

*Network structure* concerns the density and autonomy of the different actors. Density regards the formal and informal relationships between actors. These relationships tie the actors together in a network (Powell and Grodal, 2006). The network density can be influenced and changed by a hub actor in three different ways (Levén et al., 2014). First, it can influence the density by strengthening existing relationships. Second, a hub actor can initialize new relationships that are important for the innovation at hand, and thirdly, a hub actor can recruit new actors to the network whom already have relationships to existing actors. Autonomy concerns to what degree actors can take actions by themselves without interference of central control in the network. Autonomy also refers to how possible it is for an individual actor to influence the network structure (Dhanaraj and Parkhe, 2006). A hub actor can influence autonomy in a network by designing rules and structures which enable actors' autonomy, as well as supporting collaboration (Levén et al., 2014).

Finally, *network position* relates to the centrality and status of a hub actor from the perspective of involved actors in an innovation network (Powell and Grodal, 2006). Network struc-

ture can be divided into three different aspects: a) the amount of direct ties maintained by an actor firm, b) the amount of indirect ties maintained by an actor, and c) the degree to which actors are connected to each other (Ahuja, 2000). The centrality and status of a hub actor can be influenced by, for example, communicating how effective and efficient a network is (Dhanaraj and Parkhe, 2006). This includes showing what value-adding role the hub actor is playing as an orchestrator of network activities and as a network designer affecting the structural variables of network design (Levén et al., 2014).

### 3.2.2 Orchestration of Network Activities

The process of orchestration can be divided into three categories of network activities: knowledge mobility, innovation appropriability, and network stability (Dhanaraj and Parkhe, 2006).

*Knowledge mobility* concerns how easy knowledge is shared between actors in a network. A hub actor can influence knowledge mobility by increasing actors' absorptive capacity to identify, assimilate, and apply knowledge from other actors in a network (Cohen and Levinthal, 1990; Garud et al., 2013). The absorptive capacity for network actors is strengthened if actors have similar knowledge backgrounds (Mowery et al., 1996). However, if this is not the case, there is a need for facilitating knowledge mobility in order to enable knowledge transfers between actors. A hub actor can also positively influence knowledge mobility by reinforcing a common identity among actors (Dhanaraj and Parkhe, 2006). In addition, a hub actor can also influence knowledge mobility by nurturing interorganizational socialization via different exchange forums and communication channels.

*Innovation appropriability* regards innovators' abilities to capture value generated by an innovation (Teece, 1986). It also concerns how value is distributed equitably between network actors and how that distribution is perceived (Dhanaraj and Parkhe, 2006; Hurmelinna-Laukkanen et al., 2012). A hub actor needs to mitigate free riding and opportunism which typically leads to decreased commitment and negatively influences the value creation in a network. A hub actor can influence innovation appropriability, and thereby equitable distribution of value between actors, by supporting trust, procedural justice, and joint asset ownership (Dhanaraj and Parkhe, 2006; Nambisan and Sawhney, 2011). Innovation appropriability does not rest so much on formal contracts as on the trust and social interaction between network actors (Hurmelinna-Laukkanen et al., 2012). These social interactions need to account for procedural justice, i.e. aspects relating to fairness and the transparency of a decision-making process. Procedural justice in an innovation network context therefore concerns the ability to refute decisions, getting full accounts of final decisions, and a consistent and well communicated decision-making process (Dhanaraj and Parkhe, 2006).

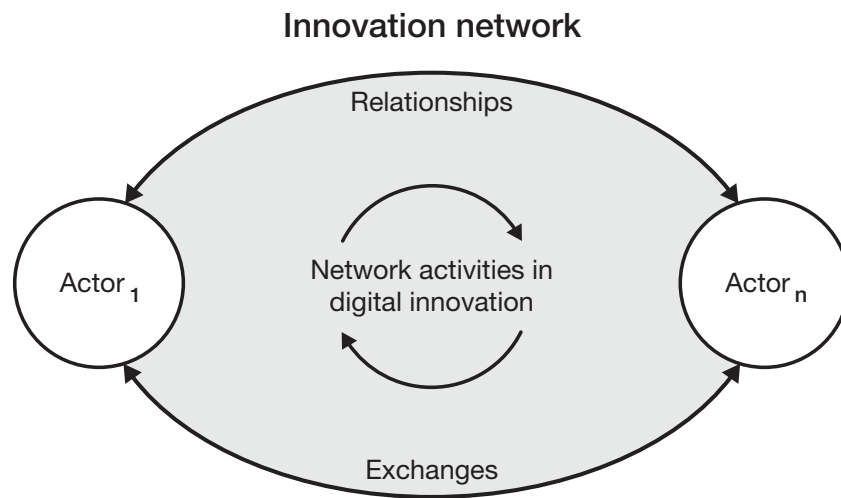
Finally, *network stability* is important for networked innovation as a network in disintegration cannot support sufficient value creation for the involved actors (Dhanaraj and Parkhe, 2006). Network stability can be positively influenced by a hub actor by, for example, enhancing network reputation and building multiplicity. Network reputation can be increased by



communicating trustworthiness and clearly showing the benefits of being a member in the innovation network (Levén et al., 2014). To support multiplicity a hub actor can support and facilitate broad and deep interactions between actors which develop an increased understanding of each other's capabilities (Hurmelinna-Laukkanen et al., 2012). These network activities tie actors together and make the network more resistant against being weakened or dissolved.

### 3.3 A Conceptual Model of Network Activities in Digital Innovation

Based on the literature review presented in section 2 and 3, the following conceptual model of network activities in digital innovation can be discerned (see Figure 1).



**Figure 1.** A conceptual model of network activities in digital innovation

Digital innovation typically occurs in *innovation networks*. Within these innovation networks *actors* such as firms, research organizations, and users are involved. The involved actors have different kinds of *relationships* and *exchange* knowledge between each other. The relationships and exchanges are initiated and facilitated via *network activities*. These activities need to be *orchestrated* in a manner that they support the ideation, design, development, and implementation of digital innovations.

### 3.4 Socio-technical Challenges with Organizing Network Activities in Digital Innovation

Innovating in a network can be viewed as a socio-technical process (Yoo et al., 2010b). Innovation is social given that, "obtaining, transforming and sharing knowledge is a negotiation and sense-making process, through which an actor's identity and relationships to others are negotiated and re-defined" (Yoo et al., 2009, p. 10). As presented in section 2 and 3, organizing activities in digital innovation is a networked and complex task. The following two subsections summarize findings from literature concerning identified socio-technical challenges to digital innovation derived from the characteristic of digital technology. As such, the subsections illuminate how characteristics of digital technology create socio-technical challenges to the organization of network activities in digital innovation.

### 3.4.1 Challenges derived from the Modular and Layered Characteristic of Digital Technology

To summarize, no single actor can deliver a digital innovation with competitive user values by themselves without knowledge, resources, and control over all the architectural layers in the digital technology (Yoo et al., 2010a; Yoo et al., 2012). This typically leads to a need for actors to come together in innovation networks. These networks require heterogeneous knowledge related to the different architectural layers of the digital technology. Therefore, actors from several different fields need to be engaged in innovation networks (Powell and Grodal, 2006; Yoo et al., 2009; Tilson et al., 2010; Yoo et al., 2012; Kallinikos et al., 2013). The networked and organizational spanning aspects of digital innovation lead to challenges related to initializing and sustaining innovation networks (Åkesson, 2009; Tilson et al., 2010; Eaton et al., 2015).

Furthermore, when innovation networks include actors with heterogeneous knowledge, interests and agendas, the translation of diverse and boundary-spanning IT knowledge is a challenging task to manage (Boland et al., 2007; Andersson et al., 2008; Lindgren et al., 2008; Yoo et al., 2009; Yoo et al., 2010a; Yoo et al., 2012; Tiwana et al., 2010).

Challenge	Description	References
Initializing and sustaining digital innovation networks	The modular and layered architecture of digital technology requires actors with diverse knowledge bases to cooperate in digital innovation. Actors' different roles, agendas, and interests challenge the initialization of networks where heterogeneous actors need to be mobilized. Furthermore, the organizational spanning aspects of digital innovation lead to challenges related to sustaining innovation networks.	Boland et al., 2007; Yoo et al., 2009; Åkesson, 2009; Tilson et al., 2010; Yoo et al., 2012; Kallinikos et al., 2013; Eaton et al., 2015
Translation of diverse and boundary-spanning IT knowledge	When actors connected to the different architectural layers of digital technology come together in innovation networks, it creates heterogeneous knowledge bases. This heterogeneous IT knowledge needs to be translated and dispersed between actors. A complicating aspect of this translation is that the knowledge needs to be dispersed over, as well as outside, organizational boundaries to enable digital innovation capacity.	Eriksson et al., 2005; Chesbrough et al., 2006; Boland et al., 2007; Andersson et al., 2008; Lindgren et al., 2008; Yoo et al., 2009; Yoo et al., 2010a, Yoo et al., 2012; Tiwana et al., 2010

**Table 1.** Challenges derived from the layered characteristic of digital technology

### 3.4.2 Challenges derived from the Generative Characteristic of Digital Technology

To summarize, the modular and layered architecture of digital technology has brought unprecedented levels of generativity (Zittrain, 2006; Yoo et al., 2012; Eaton et al., 2015). The generativity of digital technology creates unbounded opportunities for digital innovation (Zittrain, 2006; Boland et al., 2007; Yoo et al., 2010a; Tilson et al., 2010). Digital innovations are generative, i.e. adaptable, malleable, and dynamic (Zittrain, 2006; Yoo et al., 2010a; Yoo et al., 2012). Furthermore, the generativity of digital technology leads to broad and varied

consumer communities and markets (Zittrain, 2006; Yoo et al., 2010a; Yoo et al., 2012). Broad and varied markets typically lead to highly diverse user requirements and use contexts (Henfridsson and Lindgren, 2010; Yoo, 2010).

Furthermore, generativity of digital technology leads to dynamic and malleable value networks. These networks need to be dynamic, i.e. both stable and flexible, as well as be able to handle issues relating to change and control, in order to provide a foundation for innovation appropriability in digital innovation (Baldwin and Woodard, 2009; Åkesson, 2009; Tilson et al., 2010; Ghazawneh and Henfridsson, 2013; Wareham et al., 2014; Eaton et al., 2015).

Challenge	Description	References
Authenticating value	Generativity of digital technology enables unbounded opportunities for digital innovations and value propositions for consumer markets. The malleability and adaptability of digital innovations also creates a need for continuous authentications of consumer value. Furthermore, generativity typically leads to diverse and uncoordinated consumer/user communities which need to be involved in innovation networks in order to guide the development of digital innovations thusly leveraging consumer value.	Zittrain, 2006; Yoo, 2010; Yoo et al., 2010a; Tilson et al., 2010; Yoo et al., 2012; Henfridsson and Lindgren, 2010
Co-creating value	Generativity of digital technology typically requires dynamic and malleable value networks. To enable a foundation for innovation appropriability and value co-creation in digital innovation, value network configurations need to be flexible. This network flexibility concerns the support and facilitation of both change and stability whilst handling issues in relation to control.	Baldwin and Woodard, 2009; Åkesson, 2009; Tilson et al., 2010; Ghazawneh and Henfridsson, 2013; Wareham et al., 2014; Eaton et al., 2015

**Table 2.** Challenges derived from the generative characteristic of digital technology

The identified socio-technical challenges summarized in table 1 and 2 are also identified in the two cases of digital innovation studied in this thesis which are presented in the next section.

## 4. Research Methodology

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This section starts with philosophical considerations followed by a presentation of the two empirical cases studied in this thesis. Then a description of Living Lab as a research context is presented. Succeeding this is a presentation of the research design followed by a subsection about data collection as well as the analysis. Finally, the research methodology is concluded with my reflections on the research process.

### 4.1 Philosophical Considerations

This thesis is based on an interpretative perspective where a multi-method approach (Mingers, 2001) has been applied to investigate how network activities can be orchestrated in digital innovation. Social science can be polarized into positivistic and interpretive, which is also evident within the field of IS (Walsham, 1995; Silverman 1998; Klein and Myers, 1999). Positivism is primarily about testing hypotheses and correlations between variables, whereas interpretive research is concerned with descriptions and observations which might lead to the creation of hypotheses.

The choice between these different approaches depends primarily on the phenomena of interest, the context of the study and the form of knowledge that a researcher aims to produce (Silverman 1998). My argument for an interpretative approach is based on the need to capture the thoughts and actions of actors within a social and organizational setting. The setting in this case is a Living Lab, an example of an innovation network where activities in digital innovation, and the orchestration of these, have been studied. The two studied cases involve innovation networks formed around research and development projects. As such, they can be defined as a specific type of innovation network based on the definition and classification by Powel and Grodal (2004). By their definition, innovation networks based on project networks are short-term constellations aiming to accomplish specific tasks.

As interpretative research is suitable to facilitate a process of understanding, as well as provide deep insights (Klein and Myers, 1999), it was deemed as an appropriate overall approach to my research. An interpretative perspective views knowledge of reality as a social construction. As meaning is created by human actors it is also socially constructed in representations such as language and artifacts (Klein and Myers, 1999; Walsham, 2006). Hence it is necessary to conduct studies in the environment of a research phenomenon as this supports the understanding of social constructions within a research context (Silverman, 1998; Orlikowski and Baroudi, 1991). As a result, interpretative research enables the development of knowledge regarding human actors interacting with digital technology from a perspective of the participants in relation to their context (Klein and Mayers, 1999). In my research, an interpretative approach provided me with a strategy for investigating orchestration of network activities in digital innovation taking place in a Living Lab as an example of an innovation network.

This study seeks to understand how network activities in digital innovation can be orchestrated. To create an understanding of network activities in digital innovation, and how these can be orchestrated, I choose to investigate both a social and a technical perspective of the research phenomenon. This approach created a need to explore different perspectives of the actors involved in the innovation networks. Interpretative IS research has often adopted open-ended interviews as a method of investigating a phenomenon, however, there is a rather large set of interpretative research methods available (Silverman, 1998; Walsham, 2006). Given the interest in developing an understanding of the phenomena from different actors' perspectives, I choose to work with a multi-method approach (Mingers, 2001). This approach included the use of several complementary methods for data collection and analysis. This was done with the incentive to find an overall interpretive approach which provides the opportunity to explore different meanings held by different human actors involved (Ngwenyama and Lee, 1997).

Based on the discussion about style of involvement in research projects presented by Walsham (2006), I categorize myself as an involved researcher. As an involved researcher I have taken action in the two cases and provided input and feedback to the innovation networks by getting involved in the actual network activities. I, together with my colleagues, have been planning and carrying out activities in the ideation, development, and implementation of digital innovation. As such I have not merely been an observer of the orchestration of network activities in digital innovation, but have been an integral part of the process. This style of involvement has some potential pitfalls according to Walsham (2006). Firstly, it is very time-consuming. The time spent on one case study could potentially be used to do a complementary case study if a less involved style is chosen. Another potential disadvantage is that actors might be less open if they perceive that the researcher is too involved in a case. Thirdly, an involved researcher might become socialized and lose their critical distance. On the other hand, this style of involvement has many possible advantages.

Being an involved researcher is good for gaining in-depth access to the investigated research phenomena and the actors involved. This provides insights through participation in the action together with observations which is more complex than e.g. only investigating opinions in a traditional interview study (Walsham, 2006). Furthermore, being an involved researcher can provide access as the researcher makes valid contributions to the field sites instead of only observing and gathering data for his or her own interests (Walsham, 2006). As such, this style of involvement can enable a win-win situation for the researchers and the practitioners. In my case, the involved researcher role provided access to the innovation networks and the actual activities taking place within these networks. As an involved researcher I was also participating in setting up Halmstad Living Lab which for example enabled the creation of the innovation network in the Smart Lock case.

To address the potential pitfall that actors perceived me as being too personally involved, I have strived for neutrality when different actors' interests have been at play. As I have

worked with a team of researchers, we have had the opportunity to collectively reflect upon and discuss our involvement. This has been a way to address and mitigate the risk of losing our critical distance to the cases we have been involved in.

## **4.2 Empirical Cases**

This subsection presents the two empirical cases studied in this thesis. More details about the two cases are found in the individual papers.

### **4.2.1 The DigiNews Case**

In late 2003, an innovation network was formed around a research and development project called DigiNews. The innovation network formed around DigiNews initially consisted of 24 actors from nine European countries. However, some actors dropped out during the project due to lack of funding. The actors involved represented industry, SME, research labs, and academia.

The aim of the project was to ideate, develop and implement new and innovative news services based on e-paper technology, a new display technology with promising features. The main advantage of e-paper technology is that it can provide users with the same reading experience as traditional paper. It is based on a power efficient reflective display technology with high resolution. As such, e-paper technology was (and still is) a promising technology for the newspaper industry in terms of new ways of content distribution and cost reduction related to printing and distribution. An opportunity presented itself when Philips applied technologies, the developers of an e-paper device, was searching for actors who could deliver content to their device.

In DigiNews, the vision of a digitized newspaper included two parts: the e-paper device and the e-newspaper as a digital service with content that could be updated anytime and anywhere. The e-newspaper as a digital innovation based on layered digital technology exemplifies the networked aspect of digital innovation. Newspapers and advertisers had to be involved in the content layer to produce news, stories, and ads. Research labs, newspapers, and SMEs were involved in the service layer of the e-newspaper. A multitude of services were envisioned for the e-newspaper. The device layer consisted of the e-paper device which was based on an e-paper display as well as different communication interfaces to enable the distribution of content to the device. Furthermore, the e-paper device had sufficient storage capabilities for different digital content. Finally, several actors were involved in the network layer to investigate possible future communication networks which could be utilized.

Different roles, agendas, and conflicting interest of the heterogeneous actors led to several conflicts in the DigiNews case. For example, one conflict was between Philips, who developed the main prototype of the e-paper device, and the newspaper actors. Philips envisioned a scenario where newspapers only acted as content deliverers to Philips. In this vision Philips aggregated content from both newspapers and advertisers. This scenario would have

resulted in newspapers losing their relations to the readers as well as to the advertisers as customers. When actors involved in the innovation network discussed this e-newspaper vision, it became apparent that the actors had very different perspectives, goals, and interests which had to be addressed in order to sustain the innovation network.

Another challenge identified in DigiNews concerned boundary-spanning knowledge exchange between the heterogeneous actors involved. Difficulties relating to knowledge exchanges could be seen when discussing needs and requirements of the e-newspaper, as well as discussions concerning business models and value chains. Overall, there were several barriers for the newspaper industry and the consumer electronic industry to overcome in order to communicate and share knowledge and perspectives.

As an example of a digitized everyday artifact, the e-newspaper illuminates challenges related to diverse user and consumer needs and requirements. The newspaper industry wanted to reach both existing as well as new target groups and offer a digital innovation that could replace the traditional newspaper. The mobility of the e-newspaper did also create a diverse set of requirements due to the different use contexts it was meant to support. For example, the vision of the e-newspaper did not only include updated and context aware news, but also individualized advertisement delivered at the right time and location. This required insights into the consumers' wants and needs in relation to e.g. integrity.

The heterogeneity also concerned the user communities involved. From a newspaper staff perspective, the e-newspaper had to handle different type of journalists' and newspaper designers' requirements from several different organizations. For example, from a newspaper staff perspective, the e-newspaper had to provide an effective and efficient interface for their publishing system. As multiple publishing systems were used in the industry, this created diverse requirements for the design as well.

As a result of the DigiNews project an e-paper device was launched to the market by a spin-off company of Philips, called iRex. The e-paper device called the iLiad was designed for document reading and editing and not specifically for electronic news. As such, little of the initial vision of the e-newspaper published on an e-paper device was incorporated in the iLiad. However, many features innovated for the e-newspaper were implemented, for example technical display and network features, the content management system, and several user interface features. The iLiad was a forerunner to similar digital innovations such as the Sony Reader and the Amazon Kindle. Sales of the iLiad ended in 2010 when iRex filed for bankruptcy.

### **4.2.2 The Smart Lock Case**

In 2008 an innovation network was formed around a research and development project called Smart Locks. The innovation network consisted of two firms, researchers, a non-governmental organization, and actors from the municipality.

## COVER PAPER

The Smart Lock case originates from a problem concerning the inability to remotely tell if seniors' doors were locked or not. The issue generated unnecessary work for home care personnel and next of kin, as well as giving moving-impaired seniors a low feeling of security because of difficulties in checking if the front door was locked or not. There were also problems identified concerning communication issues and lack of information between care takers, care givers, and next of kin. The Smart Lock case was therefore designed to introduce digital technology that aided the seniors, the home care personnel, and the next of kin by improving the management of home care visits.

The initial vision of a smart lock was based around a digitized lock solution developed by one of the firms. This smart lock included an engine driven lock which could be opened or locked by using a digital key code transferred via Bluetooth. This allowed care personnel to utilize their cell phones as keys. By combining the digitized lock with cameras and sensors, there was an opportunity for monitoring activity, such as movement, in an apartment. The digital capabilities of the door lock also provided an opportunity to log who had opened a door and when.

The smart lock solution developed included four different components. First, there was the digitized lock. Secondly, a remote control was designed, featuring a display screen, speaker, microphone, and a button to lock and unlock the door. Thirdly, an intercom was developed which was mounted on the outside of the door which interacts with the remote control via camera, microphone and speaker. With these two devices, the seniors could easily speak to and see who was at their front door, as well as unlock the door if they decided to. Finally, a web solution (next of kin web portal) was designed and developed. On this portal the user could see logs of when the door was locked or unlocked and by whom. Furthermore, the system provided the opportunity to present photos from the video intercom. Alarm functionality was also built into the system where an alarm could be sent via SMS or email. These alarms were sent if a door was opened at certain times (e.g. late at night), or if the door has not been opened for a certain amount of time (an inactivity based alarm).

From a layered digital architectural perspective, different networks and protocols were used (GPRS, Bluetooth, TCP/IP) on different devices (e.g. mobile phones, cameras, an digitized door lock, sensors) to provide different services (e.g. alarm, log, and monitoring services) which included content such as e.g. lock logs, lock status, images, surveillance data. The two different firms enrolled in the innovation network as they together possessed the required architectural IT knowledge needed for the digital innovation at hand. One firm developed the digitized lock and the other firm developed sensors, cameras, and alarm systems. The involved seniors and next of kin provided insights about needs and requirements, as well as actively designed the SML solution together with the other involved actors.

Different roles, agendas, and conflicting interest of the heterogeneous actors also led to some conflicts in the Smart Lock case. For example, one conflict of interest between the two firms concerned their existing product portfolios and interests relating to these. One firm



was prioritizing image and video features in the system due to synergy effects with their existing product portfolio. This stood in contrast with the other firm which was focusing on digital services relating to their digitized lock solution. There were also several other issues and challenges concerning initializing and sustaining the network relationships in the Smart Lock case as well as facilitating boundary spanning knowledge exchanges between the heterogeneous actors.

The Smart Lock case illuminates similar challenges related to diverse user and consumer needs and requirements as in the DigiNews case. For example, already during the first meetings it became evident that the user and consumer groups had quite different perspectives of what features the system should incorporate. The next of kin had one perspective which differed from the involved seniors' wants and needs. For example, the next of kin wanted data about movements in the seniors' apartments, possibilities to use cameras to monitor a living space as well as information about who visited the seniors' home and when. From the seniors' perspective, many of these features were regarded as a breach of privacy and integrity. The Smart Lock case can therefore be used to illustrate similar findings concerning challenges related to heterogeneous user and consumer communities as were found in the DigiNews case.

As a result of the Smart Lock case two commercial products were launched by one of the firms. A downsized version of the remote control was developed which supported seniors' ability to remotely lock and unlock their door. The next of kin web portal was also developed and successfully launched on the market. One of these products is still commercially available on the market.

### **4.3 Living Lab as Research Context**

In this thesis, the two different cases are used to investigate how network activities can be orchestrated in digital innovation. In both cases, innovations based on digital technology aimed at end user and consumer markets were ideated, designed, developed, and tested in a Living Lab milieu. As such, the innovation networks created in the two cases were taking place in a Living Lab setting.

Bergvall-Kåreborn et al. (2009) defines Living Lab as “a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation activities engaging all relevant partners in real-life contexts, aiming to create sustainable values” (p. 3). Living Lab can be seen as both an innovation milieu and/or an approach (Dutilleul et al., 2010). As a milieu it can be seen as an environment, arena, or network supporting activities in digital innovation. As an approach it can be seen as a collection of methods and techniques to support user-centered activities in digital innovation.

Independent of definition, some common Living Lab principles can be discerned. *User centrality* traces back to the importance of identifying users' needs and experiences to be able

to launch successful digital innovations targeted against consumer markets (Eriksson et al., 2005; Rosted, 2005). Living Lab explicitly aims to involve users actively throughout an innovation process (Eriksson et al., 2005; Schumacher and Feurstein, 2007; Kusiak, 2007; Bergvall-Kåreborn et al., 2009). The Living Lab concept is also inspired by trends such as open innovation (Chesbrough, 2003) and user innovation (von Hippel, 2005). Another principle is that activities in a Living Lab are situated in a *real world context* (Bergvall-Kåreborn and Ståhlbröst, 2009). In these contexts digital innovations are both developed and validated in real life contexts i.e. authentic situations, environments and scenarios (Ballon et al., 2005; Eriksson et al., 2005; Følstad, 2008). Furthermore, *boundary spanning co-creation* can be recognized as another principle. Living Lab aims to facilitate and support the interaction between actors (Ståhlbröst, 2013). This is often done by the formation of innovation networks. These innovation networks focuses on creating value adding digital products and services (Eriksson et al., 2005).

The importance of involving a multitude of different actors e.g. industrial partners, consumer or user communities, academia, voluntary organizations and public organizations, is emphasized in Living Lab. By setting up an innovation network with actors from different backgrounds, with different perspectives, possessing different knowledge, assets and experiences, creativity is boosted. This creates a good ground for generating new ideas which can be turned into innovation and bring value through use (Eriksson et al., 2005). As a result, Living Lab is argued to have the potential to increase innovative capacity by offering knowledge transfers between involved actors. Firms, especially smaller ones, have a good opportunity to benefit from knowledge transfer enabled and supported by a Living Lab milieu (Ståhlbröst, 2013). However, the network activities taking place in a Living Lab typically require facilitation to provide these trading zones, where actors can meet and exchange perspectives, ideas, knowledge, resources, and assets (Ebbesson and Ihlström Eriksson, 2013).

Even though DigiNews was not labeled as a Living Lab case during the research project, it can be viewed as the starting point for our Living Lab at Halmstad University. The network activities to support collaboration between heterogeneous actors representing firms, researchers, and user communities working together with technical and business aspects of digital innovation is similar to how we worked later on in Living Lab. Furthermore, the way in which the evaluations of the e-newspaper were conducted in the DigiNews case was later evolved upon and is the foundation of our current Living Lab approach to evaluations of digital technology. In the Smart Lock case the innovation network was initiated by the Living Lab at Halmstad University. The Smart Lock case provides a complementary example which illustrates similar findings regarding the orchestration of network activities in digital innovation as the DigiNews case.

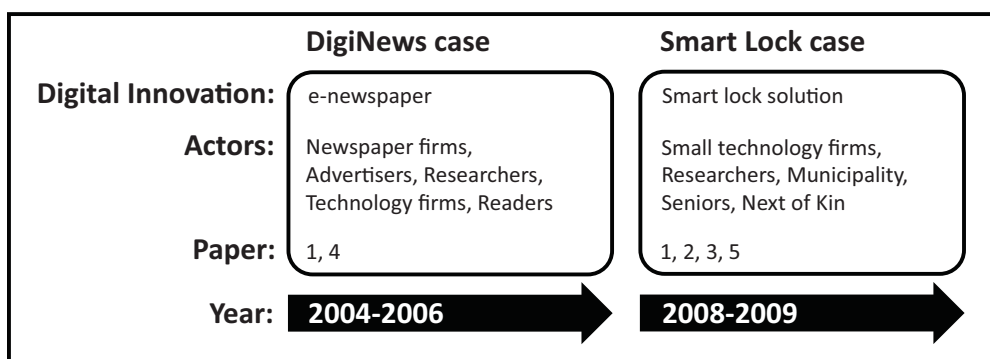
Both the e-newspaper and the smart lock are examples of digital innovation as defined by Henfridsson et al. (2009) where digital computer and communication technology are embedded into traditionally non-digital products. The cases are also good examples of digital

innovation as defined by Yoo et al. (2010a) where the combination of digital and physical components produces novel digital products or services. Both the e-newspaper and the smart lock solution were based on layered digital technology. As the different layers required different knowledge, actors such as firms had to come together in innovation networks. The firms involved came from different industries, of different sizes, with different incentives, and were involved in the innovation network with actors such as researchers, organizational users, and consumer groups and other actors (e.g. voluntary organizations, organizations within a municipality, business customers, and advertisers) to ideate, design, develop, and test the digital innovations.

The network activities were organized in a process which can be characterized as highly ambiguous. This process included activities which could handle emergent properties of the technology as well as the design domain. Furthermore, the network activities in both cases had to be organized in a way that initiated and sustained relationships between actors with diverse and sometimes conflicting interests as well as supporting exchanges of knowledge between said actors. Both cases were inspired by user centric design and included a high degree of user involvement. Furthermore, both cases were action oriented and utilized a multi-method approach (Mingers, 2001) including both qualitative and quantitative studies.

The differences between the two cases primarily concerns scale aspects. The innovation network formed around the DigiNews case included a multitude of actors whereas there were only six actors involved in the Smart Lock case. Additionally, the size of the firms involved differed, which influenced the amount of resources available for each case e.g. technical development of prototypes and demonstrators.

Figure 2 presents a summarization of the different cases including actors involved and individual papers in relation to the two cases.



**Figure 2.** Summarization of the empirical cases

#### 4.4 Research Design

I have adopted a multi-method approach in order to gain a rich understanding of orchestration of network activities in digital innovation. In a multi-method approach, researchers use two or more methods of data collection and analysis. These research methods may, or may not, be restricted to one worldview, e.g. qualitative or quantitative (Venkatesh et al., 2013). The main reason for a multi-method approach is that the use of different methods has the ability to generate a comprehensive understanding of an interrogated research question (Mingers, 2001). This understanding is enabled by the different method's ability to capture different aspects of a phenomenon. By using different data collection methods and techniques in my research, different aspects of network activities in digital innovation, and the orchestration of these, could be investigated. A multi-method approach was selected due to the need for investigating both technical and social perspectives of orchestration of network activities. Another reason for selecting a multi-method approach is that innovation research is by nature multi-layered and spans over multiple levels of analysis (Gupta et al., 2007). Different analysis and multiple theoretical frameworks are therefore needed to understand the complexity of digital innovation taking place in innovation networks (Vanhaverbeke and Cloudt, 2006).

By utilizing a multi-method approach, a researcher may benefit from different methods as the interpretation and analysis of the collected data may reveal different perspectives of a phenomenon (Sawyer, 2000; Mingers, 2001). Combining methods therefore allows a rich understanding of a phenomenon as they focus on different aspects (Jick, 1979; Mingers, 2001; Morse, 2003). By combining different research methods, I therefore had the opportunity to develop comprehensive descriptions and explanations of network activities in digital innovation and their orchestration. Another argument for choosing a multi-method approach is based on the view of research as a process. As different types of research activities makes different methods useful at different phases of research (Mingers, 2001), this approach was considered appropriate. A multi-method approach could therefore support a continuous development of my understanding of orchestration of network activities in digital innovation. This was enabled by providing different methods during my research process to be able to gather and analyze data based on my different needs and understanding.

In this thesis, two different cases are used and several different actors' perspectives are incorporated into the studies. The research has interrogated different actors' perspectives on orchestration of network activities in digital innovation within these two cases. Actors who have been involved in my research are, for example, user communities, designers, developers, and business and management representatives from the involved firms. The studies have been conducted during different phases of digital innovation. I have therefore had the opportunity to investigate different theoretical perspectives and empirical aspects of orchestration of network activities in digital innovation during my research. Both empirical and theoretical insights during my studies have influenced my continuous data collection during the two cases. A process which can be characterized as iterative in the sense that I have had

an opportunity to follow up on empirical and theoretical findings from the two cases during my thesis work.

The multi-method approach utilized in this thesis includes the use of interviews, workshops, observations, study of internal documents, and surveys. Interviews are often used in interpretive studies, but they should be complemented with additional methods, such as observations, to provide a rich source for interpretations (Walsham, 2006). Even if a multi-method approach does not require interaction between the methods (Mingers, 2001), this was often the case in my studies. Interviews were often either informed by surveys or vice versa. This was also the case concerning other methods, for example workshops, which often generated input for data gathering later on in the cases. The use of a multi-method approach therefore expanded the scope and width of my research and enabled a comprehensive understanding of the studied phenomenon.

## **4.5 Data Collection and Analysis**

The data collection activities will be briefly presented in the following section divided by the two cases. More details on data collection and analysis are presented in the individual papers.

### **4.5.1 Data Collection in the DigiNews Case**

The data collection for network activities in DigiNews can be divided into three sets of data which are primarily generated from design and business model studies conducted within the case. From an innovation perspective, these sets can be roughly related to the invention, development, and implementation parts of the e-newspaper.

The first data set from the case related to need-finding and requirement elicitation for the e-newspaper. This data was gathered during eight workshops and ten focus group meetings. To ensure the involvement from relevant actors in the network activities, users, advertisers, and newspaper designers were involved in both the workshops and in the focus groups. In these activities concepts and prototypes of the e-newspaper were generated, developed, and evaluated iteratively.

The data regarding activities from the second set was based on the evaluation of prototypes and an early version of an e-newspaper. The prototype testing was initiated in the autumn of 2005 and focused on testing different design solutions. Furthermore, we investigated user attitudes towards the e-newspaper concept via interviews with the 36 individuals that tested the prototypes. Observations, interviews, and questionnaires were used to collect the data. An online questionnaire followed the prototype test to further investigate and validate the findings from the interviews. The main focus of the questionnaire was business models as well as e-newspaper and mobile news-service preferences.

The final set of data regarding activities from the DigiNews case was initiated with a real life evaluation of the e-newspaper. Ten families were involved in testing an early version of an e-newspaper published on an e-paper device. The evaluation was conducted during two weeks

in the families own home during the autumn of 2006. This evaluation primarily focused on testing the e-newspaper platform, exploring the pros and cons with this digital innovation, as well as investigating users' preferences and intentions to adopt. Online diaries, questionnaires, and interviews were used to collect the data.

Following the real life test were seven interviews with eight respondents. The interviewees represented five newspaper actors and two technology actors. The interviews were built around specific themes, e.g. value networks and business models of the e-newspaper, technical and design aspects, and different technologies' influence on the organization and management. As such, the interviews included several aspects relating to network activities in the implementation phase of the e-newspaper. The third data set was also using documentation as a source to study network activities in the DigiNews case. The documentation included the project application, meeting minutes and agendas, and preliminary and final reports. The different data collection activities from the three data sets are presented in table 3.

	Data collection	No. of respondents	Type of data
<b>Data set 1:</b> Invention	Needs and requirements	54	8 future workshops and 10 focus group meetings
<b>Data set 2:</b> Development	Prototype testing	36	Observation, interview, questionnaire
	Validation	3626	Online questionnaire
<b>Data set 3:</b> Implementation	Real life evaluation	12	Online diary, questionnaires, interviews
	Interviews	8	Interviews with newspaper and technology actors
	Documentation	-	Reports, agendas, minutes from meetings

**Table 3.** Data collection activities in the DigiNews case

The collection of data was conducted by several researchers at Halmstad University. I was involved in collecting data for all three sets and responsible for several of the data collection activities within the case.

#### **4.5.2 Data Collection in the Smart Lock case**

The data collection for network activities in the Smart Lock case can also be divided into three sets of data which correlate with the invention, the development, and the implementation of a digital innovation.

The first data set regarding network activities concerned the need finding, idea generation, and market analysis done in the invention phase. During the first data set idea generation workshops, future workshops, and focus groups were conducted involving seniors, NGO representatives, and representatives from the firms. Two different types of focus groups were created. The first group that consisted of next of kin worked closely with the IT-developers to generate and form ideas. The other groups consisted of seniors and next of kin and acted as reference groups who continuously evaluated the ideas, concepts, and prototypes developed. The data collection during the first data set included four interviews with the firm actors, two initial workshops and one questionnaire.

The second data set concerned the development of the smart lock solution in the case. During this phase, the involved users designed the actual device through mock-ups, scenarios, and iterative prototyping. Continuous evaluation of the design was done by the secondary focus groups. The researchers facilitated these network activities and the firms acted as technical advisors to the focus groups of users. The gathering of data for the second data set was concluded by the actual development of the hardware and software. This development was based on requirements and prototypes delivered from the focus groups. The data collection about network activities in the second data set included 18 workshops, one group interview with the focus group, one interview with a formal next of kin representative and three formal meetings with the firms.

The third data set concerned the implementation and evaluation of the smart lock solution. It included a real-life testing of the developed prototype. During the real-life testing, seniors and next of kin were able to test the prototype in their own homes for a few weeks. The data collection included three questionnaires and interviews with the users testing the prototype. Furthermore, one group interview with the focus groups was conducted. One interview with the formal next of kin representative and two interviews with the firm actors involved were also conducted. Finally, notes from meetings between actors in the innovation network, field notes, archival documents, and reflections by researchers involved were included as data about network activities in the third data set. The different data collection activities from the three data sets from the Smart Lock case are presented in table 4.

	Data collection	No. of respondents	Type of data
Data set 1: Invention	Idea generation, need analysis, requirement elicitation	22	2 initial workshops with all actors and 4 interviews with firm actors
	Validation of findings	60	1 questionnaire sent out to seniors
Data set 2: Development	Prototype development and evaluation	32	18 workshops
	Validation	14	1 group interview with users, 1 interview with user representative, 3 formal development meetings with firm actors
Data set 3: Implementation	Real life evaluation	16	3 questionnaires and 1 interview
	Interviews	11	1 Interview with focus groups, 1 interview with next of kin representative, 2 interviews with firm actors
	Documentation	-	Notes from meetings, field notes, archival documents

**Table 4.** Data collection activities in the Smart Lock case

The collection of data was conducted by several researchers at Halmstad University. However, I was involved and responsible for all the data collecting activities in all three sets of data.

#### 4.5.3 Data Analysis

The data from the two cases has been analyzed with different methods and theoretical perspectives based on the focus of the individual papers. The qualitative data from the two cases, e.g. data from interviews and workshops, has been analyzed based on theory guided themes and coding. In order to categorize and make the data more manageable, patterns were identified with the help of the different theoretical frameworks used (Miles and Huberman, 1994). Excerpts in the data were marked with assigned colors, facilitating data categorization according to corresponding theoretical themes. Within these marked excerpts, data was scanned to identify similarities and differences between the excerpts. When differences occurred and new themes emerged these were again coded. The new theme was then once again examined against the whole dataset. This approach therefore iteratively provided me with a richer understanding of the qualitative data.

Data from the Smart Lock case has also been analyzed based on a process analysis. A temporal bracketing strategy (Langley, 1999) was used to create comparative units of analysis for the exploration of theoretical ideas. As mutual influences are difficult to study at the same time, it is easier to analyze data in a sequential process by temporarily "bracketing" one of the data streams. By decomposing data into successive periods, this strategy enables



## COVER PAPER

studies of how actions of one period lead to changes in the context that will influence actions in following periods (Langley, 1999).

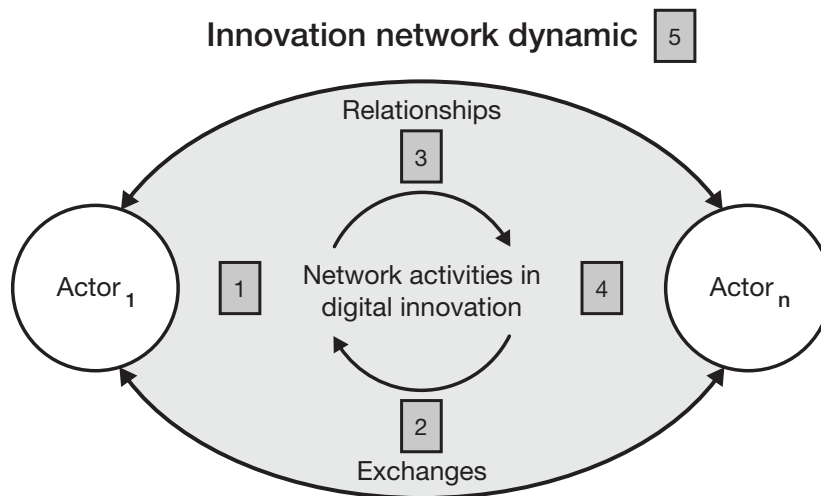
Table 5 presents a summarization of the individual papers in relation to theoretical foundations used, methods, data collection and analysis conducted.

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5
Case	DigiNews and Smart Lock	Smart Lock	Smart Lock	DigiNews	Smart Lock
Theoretical foundation	Innovation processes and networks, customer involvement, types of users	IT-innovation, innovation networks, cognitive and social translation	Digital innovation, innovation networks, alliances, relationships and ties	Digital innovation, characteristics of digital technology, activities in innovation, innovation actors	Digital innovation, innovation network dynamics, architecture of digital technology
Method	An exploratory multi-method approach	Interpretative case study	Interpretative case study	Interpretative case study	Interpretative case study
Data	Data from 100 user involvement activities	Workshops, interviews, field notes, documentation	Workshops, interviews, field notes, questionnaires, documentation	Workshops, interviews, observations, user diaries, questionnaires, documentation	Workshops, interviews, field notes, documentation
Analysis	Descriptive analysis	Thematic coding	Thematic coding	Thematic coding	Process analysis
Contribution	Suggests network activities which support and facilitates the involvement of heterogeneous user communities in digital innovation	Describes network activities which support and facilitate knowledge exchanges in digital innovation	Addresses network activities which support and facilitate relationships between actors in digital innovation	Presents activities which addresses identified socio-technical challenges with digital innovation	Explains the interplay between digital technology and innovation network dynamic in digital innovation

**Table 5.** Summarization of the individual papers

Inspired by Walsham (2006), this thesis uses different theoretical perspectives to investigate and analyze the phenomenon of orchestration of network activities in digital innovation. If only one theoretical perspective is adopted to investigate a research question, there is a risk for a limited view (Mingers, 2001). As presented in table 5, the individual papers use a digital technology perspective, an innovation process perspective, an activity perspective, and an innovation network dynamic perspective. As such, the different theoretical perspectives uti-

lized in the individual papers provided me with complementary views of the investigated research phenomenon.



**Figure 3.** Individual papers in relation to the concepts used in the cover paper

As shown in Figure 3, the individual papers study network activities in digital innovation. Paper 2 and 3 specifically highlight how network activities influence relationships and exchanges between actors in innovation networks. Paper 1, 4 and 5 have a focus on network activities in digital innovation as well as how these can be orchestrated. Together, the five papers provide the foundation for the cover paper to investigate the research question. The individual papers are utilized to analyze how the identified challenges with organizing digital innovation (presented in section 3.4) were either successfully, or unsuccessfully addressed, and what implications this resulted in. The insights from the individual papers, viewed through the theoretical lenses of network orchestration and activities in innovation, enabled an analytical way to address the research question concerning how network activities can be orchestrated in digital innovation.

#### 4.6 Reflections on Research Process

My research process has been both a theoretical and empirical journey where my interests and knowledge have evolved over time. As new empirical and theoretical findings have emerged, I have also changed and developed my research focus. The main reason for this fluidity and adaptability is that I have studied a contemporary research phenomenon in which both practice and theory have evolved during the time of my studies. The understanding of orchestration of network activities in digital innovation has continuously evolved and matured as empirical and theoretical findings have been presented within the research field. I therefore needed to adapt my theoretical perspectives continuously based on my own findings as well as findings within the research field.

Reflecting on my process, three overall perspectives can be discerned during my journey. In my role as a research assistant around 2004, before being admitted into Ph.D. studies, I started out working within the field of User Centered Design. I was mainly interested in

methods and tools for involving users in the development of digital products and services. The work was guided by the idea that satisfying usability and user experience of digital products and services could be achieved by user involvement throughout a digital innovation process. However, the digital products and services we were working with at the time were not aimed towards organizational users, instead it was consumer products. This led me to the innovation literature where I became interested in user involvement in relation to innovation. This expanded my perspective, both from an empirical as well as a theoretical point of view.

This expansion led me into a new overall research interest concerning how to organize activities in digital innovation, during which time I was still convinced that user involvement was the most important aspect. However, studying literature about user driven innovation and open innovation broadened my perspective to realize that involving only users was not enough; there was also a need to involve a more diverse set of actors in order to launch successful digital innovations. Around this time we were also looking into some of the business aspects of innovation. This was reflected in the empirical work when we started to work with methods for business modeling to support the activities in digital innovation we were involved in. Another theoretical perspective incorporated in my work concerned adoption and diffusion of innovations. This resulted in some studies using these theoretical frameworks.

From initially only looking at a user perspective, I started to view activities in digital innovation from an innovation network perspective. While reviewing the literature, and at the same time looking back at my empirical cases, an opportunity to study dynamics of heterogeneous innovation networks emerged. These insights were useful towards being able to setup innovation networks, as well as facilitating and supporting the formation of relationships and exchanges between the involved actors.

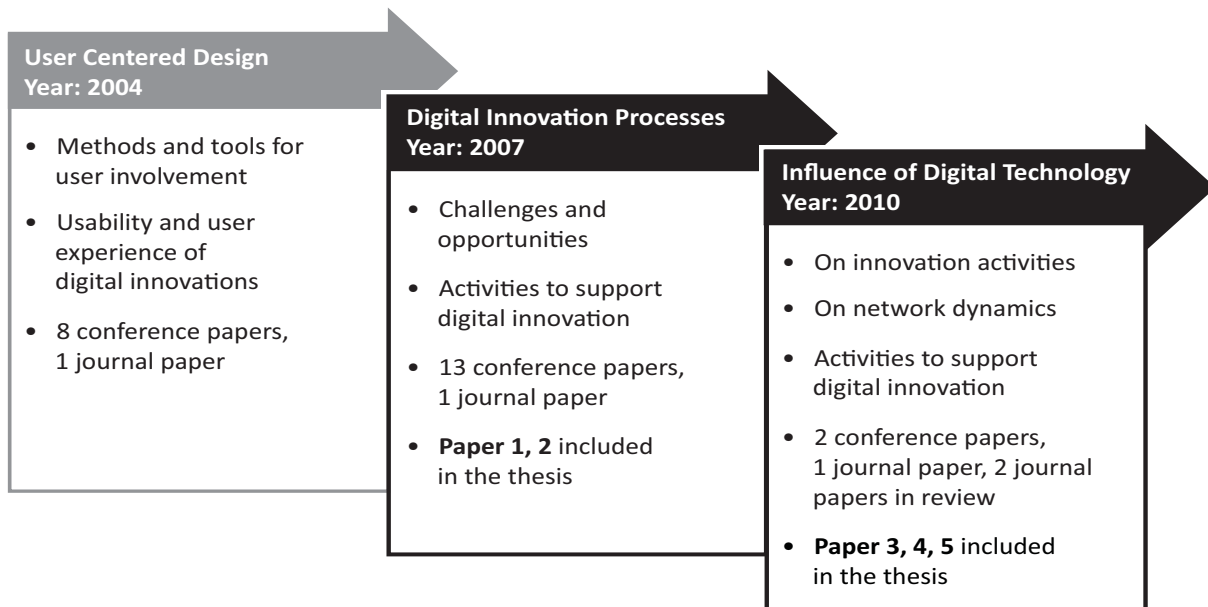
The innovation network perspective surfaced in the end of 2007, around the same time as I was admitted as a Ph.D. student. Around this time my research group started to setup Halmstad Living Lab. Living Lab was particularly interesting for me as it related closely to my new perspective of digital innovations aimed at consumer markets. I therefore took an active role in organizing several of our network activities within the Living Lab. I worked with both developing our Living Lab approach in our existing projects, as well as applying for and managing new research projects relating to Living Lab. Not only did I continue to work with methods and tools to involve users in digital innovation, but also started to study how to involve other actors that are needed to be able to innovate successfully.

In Halmstad Living Lab we constantly looked for opportunities to work with new technology in emergent design domains. In this thesis, the e-newspaper (enabled by e-paper technology) and the smart lock solution (enabled by digital locks) were selected as two appropriate cases to investigate how network activities can be orchestrated in digital innovation. Living Lab as a milieu was also considered as a suitable context to study digital innovation. As shown in this thesis, there is a good alignment between the theoretical concepts used to

describe activities in digital innovation and the overall concept of Living Lab where these network activities take place.

The new theoretical perspective led to studies regarding innovation network dynamics in digital innovation. Furthermore, this theoretical perspective highlighted activities within these networks. As such, this perspective emphasized my focus on network activities in digital innovation and how these could be orchestrated. Moreover, at this time the literature about digital innovation had evolved and I was now starting to explicitly incorporate these ideas into my research. This has led to the notions and concepts, as well as the literature used in the papers, mirroring the development of the research field of digital innovation. My research focus has therefore been aligned with contemporary research which has continuously provided me with an updated vocabulary and insights to analyze and understand my empirical findings.

This reasoning can be exemplified with the work conducted in paper 5. In this paper we explicitly analyze the Smart Lock case based on changes in the architectural layers of the digital technology used. By doing so, insights into how architectural changes interplay with innovation network dynamics could be derived. The analysis was a result of viewing the technology from a modular and layered architectural perspective. This perspective was incorporated from the digital innovation literature and as such, it provided a new way of understanding the empirical findings.



**Figure 4.** Research interests during the Ph.D. project

Figure 4 summarizes the evolvement of my research process and interests as well as publications within the different domains. The first arrow in gray represents research interests before starting my actual Ph.D. studies.

## 5. Research Papers

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This thesis is a collection of five international peer-reviewed papers. Four papers are published and one paper is to be revised and re-submitted to a third round of review for an international IS journal. In addition, 19 conference papers and two journal papers have been published. These papers either overlap, or relate to the research question in the thesis. An overview of the five appended papers is presented in table 5 in the previous section. The additional papers are presented in table 6 in section 5.6. Below I present a brief introduction and summary of the five appended papers.

### 5.1 Paper 1: Activities to Enable User Involvement in Innovation Networks

This paper discusses user contribution in digital innovation from a Living Lab perspective. The paper focuses on methods and techniques for user contribution in digital innovation by discussing experiences based on 100 activities conducted within four different research projects. The purpose of this paper is to discuss experiences of user involvement activities in digital innovation, in relation to Living Lab, as well as to: a) phase in the innovation process, b) kind of user contribution and c) type of users.

The paper utilizes literature about Living Lab which is described both as a milieu and an approach for innovation. In this milieu, methods and techniques are used to empower users and to involve all relevant actors in open innovation processes, taking place in realistic settings. Furthermore, five identified Living Lab key principles are presented. These are *Continuity*, *Openness*, *Realism*, *Empowerment of users*, and *Spontaneity*. The paper also presents some different models describing innovation processes and highlights the Customer Integration Cube (CIC). CIC divides innovation into four phases: *idea*, *concept*, *prototype*, and *market*. Moreover, CIC includes three different kinds of user contribution that can be made during the innovation process; *decision*, *information* and *creation*. Finally, in terms of user contribution, CIC suggests a classification of four different types of users that could/should be involved in the innovation process: *freshman*, *intuitive*, *nerd* and *pro*.

Halmstad Living Lab was established in 2007, but the research group involved has worked with user involvement in innovation processes since 2004. Halmstad Living Lab has worked with different types of methods such as focus groups, future workshops, prototyping, surveys, usability tests, evaluation and validation. Furthermore, a multitude of techniques were used, e.g. the creation of personas representing archetypes of possible future users, scenario building, the construction of mock-ups during early design, brainstorming, image boarding, interviews, questionnaires, diaries, observations, task-oriented tests, and think aloud. The experiences gained from these activities serve as a foundation for comparing and discussing methods and techniques with different types of users in different phases of digital innovation processes.

The contribution of the paper is threefold. First the Customer Innovation Cube model is modified to better suit digital innovation in Living Lab milieus. Secondly, the paper discusses activities for user contribution in relation to the modified model as well as to Living Lab and the five identified key principles. Finally, the paper presents several issues regarding different kinds of user contribution and types of users that need to be considered in digital innovation within a Living Lab. For example, three issues relating to kinds of user contributions are presented: handling required output in different innovation phases, the resources needed for these activities, and the facilitator role. Furthermore, four issues are presented related to the types of users involved: composition of user group, providing different perspectives on innovation, conflicting interests between user communities (and other actors), and identifying and motivating relevant users.

*Svensson, J., Ihlström Eriksson, C., and Ebbesson, E. (2010). User Contribution in Innovation Processes - Reflections from a Living Lab Perspective. In Proceedings of HICSS'43, Kauai, Hawaii, January 5-8.*

## **5.2 Paper 2: Actors Exchanges and Relationships**

This paper is based on the Smart Lock case which is used to investigate knowledge exchanges and actor relationships in an innovation network. By identifying and empirically exemplifying how cognitive and social translations occurred, insights are presented concerning how to support knowledge exchange and relationship facilitation in these kind of innovation networks where activities in digital innovation takes place. Using the theoretical concepts from Yoo et al. (2009) the paper explores the research question: how can cognitive and social translation be supported in a Living Lab?

The paper utilizes literature about innovation networks, and cognitive and social translation. Two generative forces shape innovation networks in digital innovation: 1) "ICT reduces communication cost and increases speed and reach which amplifies the distribution of control and coordination among actors", and 2) "digitization of products and services and resultant digital convergence increases heterogeneity (and conflict) of knowledge resources in innovation networks". The term cognitive translation can be defined as a "generative process whereby knowledge is produced, refined, integrated, evaluated and materialized at least partially by digital means in order to reach an innovation closure, i.e. when the innovation is stabilized as a new product or service". Social translation relates to the translations which typically occur at the boundaries of communities where heterogeneous actors connect, negotiate and adjust to each other's perceptive which redefines the social space.

To examine how cognitive and social translations can be supported in Living Lab, events in the Smart Lock case were studied. The data collection process covers six formal interviews performed with SME representatives, three group interviews with the focus group participants and three interviews with representatives for user communities in the innovation network. For the purpose of this paper, different aspects of cognitive and social translations

were chosen as an analytical lens to find and highlight episodes of the gathered data to better help understand the investigated phenomenon and address the research question.

Based on the findings, the paper concludes that Living Lab as an innovation network can support a heterogeneous set of actors and knowledge resources by supporting cognitive translation with techniques such as scenarios, mock-ups and prototypes. By working with iterative activities in digital innovation, the involved actors can be supported to materialize prior and new knowledge which can be translated and exchanged between different communities of actors. By setting up and providing a common ground, a trading zone can be established to support the social translations and the relationships within the innovation network by offering a space where negotiation of interests and alignment of perspectives can be facilitated.

*Svensson, J., and Ebbesson, E. (2010). Facilitating Social and Cognitive Translation in Innovation Networks. In Proceedings of MCIS 2010, Tel Aviv, Israel, September 12-14.*

### **5.3 Paper 3: Socials Aspects Influence on Actors in Innovation Networks**

This paper uses the Smart Lock case to study network activities in digital innovation. Activities in digital innovation are becoming more and more networked, and actors are growing dependent on each other's competences, resources and knowledge. In innovation networks developing digital innovation, actors need to identify, mobilize, and integrate diverse and heterogeneous knowledge resources to be able to innovate successfully. Social aspects are important where heterogeneous actors connect, negotiate, and adjust to each other's perspectives. The aim of this paper is to explain how social aspects such as trust, commitment and power, influence changes in relationships in digital innovation networks.

The paper utilizes literature about digital innovation and innovation networks. Interorganizational innovation networks are common in digital innovation, and these might either be temporary short term networks or long-lasting networks. Trust is identified as one of the most important social aspects to building relationships in innovation networks that lead to the successful exchange of knowledge and innovation potential. A second social aspect highlighted in literature is commitment. The commitment by the involved actors influences the relationships between the same actors in the network and is suggested to be interlinked with interest. Finally, power has been identified as an important social aspect influencing relationships. Research also highlights the importance for hub actors to not only have a central position within a network, but also to play an "in-between" role or to have boundary spanning positions in order to be able to gain or withhold power. Finally, the literature presents two dimensions of network relationships that differentiate networks: deep versus wide relationships and formal versus informal relationships.

The Smart Lock case was selected to study events involving multiple actors in an innovation network. The relationships studied were categorized as interorganizational. The relationships analyzed existed between companies, researchers, and a non-governmental organiza-

tion (NGO). The model of interfirm ties by Simard and West (2006) was used to structure the data from the case and social aspects influencing changes in the relationships have been chosen as an analytical lens. This lens has been used to find and highlight episodes of our gathered data, and helped to better understand the empirical findings as well as to address the aim with the research.

The analysis of the Smart Lock case shows how social aspects such as trust, commitment, and power among actors influence and change the relationships. Trust and commitment is a gradual and sequential process, with each following the other to higher levels. Commitment and power is interrelated, while identification and clarification of actors' resources in a network influences their power. These social aspects need facilitation to build and manage relationships in innovation networks as well as create changes in these relationships. The need for a change in a relationship is related to whether innovation potential is sought after or if exploitation of knowledge is the primary objective of the relationship. These findings are articulated in a model for how social aspects influence changes in network relationships and the paper is concluded with six propositions based on the model.

*Svensson, J. and Ihlström Eriksson C. (2012). Exploring Social Aspects Influence on Change in Network Relationships - a Case Study of Digital Innovation. International Journal of Social and Organizational Dynamics in Information Technology, 2(4), pp. 14-33.*

#### **5.4 Paper 4: Activities to Address Challenges in Digital Innovation**

This paper investigates specific challenges relating to actors' interactions in digital innovation. The challenges primarily relate to the relationships and exchanges between actors in innovation networks working with digital innovation. By identifying challenges with digital innovation in related literature, and presenting suggestions of network activities to address these based on empirical findings, this paper primarily contributes with actionable insights into the emerging field of digital innovation.

This paper is based on a literature review which identifies four socio-technical challenges relating to actors' interactions in digital innovation. The first challenge is named *modular co-operation*. As different architectural layers of digital technology typically require actors with diverse knowledge bases to co-operate in innovation networks, digital innovation processes become networked and complex. The second challenge is named *knowledge exchanges*. Knowledge between heterogeneous actors needs to be dispersed in innovation networks to enable innovation capacity. The translation and exchange of knowledge between heterogeneous actors is challenging. The third challenge is named *diverse consumer groups* and is summarized as follows. Generativity of digital technology enables adaptability of a digital innovation after it is implemented. This generativity leads to large, diverse, and uncoordinated user communities and markets. The fourth and final challenge is named *heterogeneous user requirements*. Large, diverse, and uncoordinated audiences of digital innovations lead to multiple use contexts and heterogeneous user requirements. These heterogeneous requirements are challenging the design and development of digital innovations.



To enable the exploration of the research question a multi-method approach was chosen. This paper is built on a two-step process. First, it summarizes socio-technical challenges in digital innovation based on a review of related literature. Secondly, it investigates the DigiNews case to identify network activities which addressed the challenges. The DigiNews case was deemed suitable to do a retrospective analysis due to a) the e-newspaper being an example of a digital innovation as it concerns the embedding of digital computer and communication technology into a traditionally non-digital product, and b) DigiNews enables an analysis of the process of creating new combinations of digital and physical components that produce novel products or services.

The DigiNews case illustrates all four identified challenges and also illuminates some network activities which can address these challenges. Based on empirical findings, the paper presents eight activities which address the identified socio-technical challenges with digital innovation. To address the challenge of modular co-operation, the following three activities are suggested: a) *support transparent digital ecosystem relationships*, b) *facilitate cross-organizational communication*, and c) *create digital value blueprints*. To address the challenge of knowledge exchanges it is suggested to have activities that *translate heterogeneous knowledge*. To address the challenge of diverse consumer groups, the following three activities are suggested: a) *involve all relevant user groups*, b) *identify, design for, and authenticate digital user values*, and c) *design for multiple contexts of use*. Finally, to address the challenge of heterogeneous user requirements, it is suggested to *prototype iteratively*.

*Lund, J. (2014). Activities to Address Challenges in Digital Innovation. Proceedings of IFIP WG 8.2: Information Systems and Global Assemblages: (Re)Configuring Actors, Artefacts, Organizations. Auckland, New Zealand, December 11-12.*

## **5.5 Paper 5: Interplay between Digital Technology and Innovation Network Dynamics**

This paper aims to increase the understanding of how different architectural layers of digital technology interplay with network dynamics in digital innovation. The digitization of analogue products and services has a profound impact on the practice and research of information systems. Some of these impacts of digitization can be traced back to the architecture of digital technology. As different layers of digital technology require different knowledge, organizations need to collaborate in innovation networks to be able to succeed with digital innovation. By gaining a better understanding of how different layers of digital technology interplay with innovation network dynamics, we can be better prepared for orchestrating complex innovation processes that often arise when working with digital innovation.

The paper utilizes literature on digital innovation, digital technology and infrastructure, and innovation network dynamics from the perspective of knowledge exchange and relationships. The knowledge work in innovation processes which involves heterogeneous actors is not a matter of just processing more and more knowledge. It is a process of transforming and exchanging knowledge between actors in a network. This transformation and exchange

of knowledge can be seen as both an opportunity for, as well as a barrier against innovation. Furthermore, the network relationships influence this knowledge exchange between actors.

The Smart Lock case was selected to study events involving multiple actors in an innovation network. A temporal bracketing strategy was used to support a process analysis of the case data. The model of layered digital technology was used as a lens to structure data from the case. Changes in the layered digital technology were used as key events to identify possible points of interest that could encompass related changes in the network dynamics, i.e. changes in relationships or exchanges between actors in the innovation network. This analytical lens, together with the literature on innovation network dynamics, was used to analyze the empirical findings.

The empirical findings suggest that the nature of the interplay between digital technology and network dynamics consists of a continuous ebb and flow between malleable and crystallized phases driven by generativity on the architectural layers of the digital technology. During malleable phases, the innovation network strives to connect actors with complementary expertise within each layer in order to then enable a crystallization of the digital innovation at hand. During crystallized phases, the network stabilizes and provides a foundation for further malleability spawned by generativity on the architectural layers. The empirical findings also suggest that generativity spawned from the architectural layers can leverage digital innovation, as long as the innovation network allows for flexibility in terms of reconfiguration of roles and relationships. This leads to the conclusion that modification of specific layers in the digital architecture creates ripple effects in the network surrounding the digital innovation.

*Lund, J., and Ebbesson, E. (2013). The Interplay between the Architecture of Digital Technology and Network Dynamics in Digital Innovation. To be re-submitted to a third round of reviewing to the Scandinavian Journal of Information Systems.*

## **5.6 Related Research Papers**

The five appended papers together with the cover paper provide the answer to how network activities can be orchestrated in digital innovation. However, I have authored and co-authored 21 additional papers which relate to this question. Some of these papers use other cases, extracted from the multitude of research projects I have been involved in, but most of them use the DigiNews and the Smart Lock case as well. Therefore, these papers are also representations of my research process as a Ph.D. student, even if some of them are written before I got admitted. Table 6 presents the papers which are not included in the thesis, either due to overlap or somewhat out of scope in relation to my research question. All but one paper was written under my previous surname Svensson.

## COVER PAPER

Journal paper
Ihlström Eriksson, C., Åkesson, M., Svensson, J., Fredberg, T. (2007). Introducing the e-newspaper: identifying initial target groups. <i>Journal of Media Business Studies</i> , 4(3), pp. 41 - 62.
Ihlström Eriksson, C., and Svensson, J. (2009). A User Centered Innovation Approach Identifying Key User Values for the e-newspaper. <i>International Journal of E-Services and Mobile Applications</i> , 1(3), pp. 38-78. Authors presented in alphabetical order.
Conference papers
Svensson, J. and Ihlström Eriksson, C. (2013). Social Aspects Influencing Relationships in Digital Innovation Networks – The Smart Lock case. In <i>Proceedings of HICSS'46</i> , Maui, Hawaii, January 7-10.
Ståhlbröst, A., Bertoni, M., Følstad, A., Ebbesson, E., and Lund, J. (2013). Social media for user innovation in Living Labs: a framework to support user recruitment and commitment. Presented at the XXIV ISPIM Conference, Helsinki, Finland, June 16-19.
Ebbesson, E., and Svensson, J. (2012). Criteria for social software implementation in Living Labs. In <i>Proceedings of Innovation through Social Media (ISM)</i> , Oslo, Norway, December 3.
Svensson, J. and Ihlström Eriksson, C. (2012). The Role of Social Aspects in Digital Innovation Networks - A Living Lab Case Study. In <i>Proceedings of IRIS'35</i> , Sigtuna, Sweden, August 17–20.
Lahti, A., Naraha, S., Svensson, J., and Wärnestål, P. (2012). Ethical Heuristics – A Tool for Applying Ethics in User-Involved IS Projects. In <i>Proceedings of IRIS'35</i> , Sigtuna, Sweden, August 17-20.
Svensson, J. (2012). Living Lab Principles: Supporting Digital Innovation. In <i>Proceedings of XXIII ISPIM Conference</i> , Barcelona, Spain, June 17-20.
Svensson, J., Ihlström Eriksson, C., Ebbesson, E., and Åkesson, M. (2009). Methods and Techniques for User Contribution: Challenges from a Living Lab Perspective. In <i>Proceedings of IRIS'32</i> , Molde, Norway, August 9-12.
Svensson, J., and Ihlström Eriksson, C. (2009). Open Innovations in Small Enterprises - A Living Lab Approach. In <i>Proceedings of XX ISPIM Conference</i> , Vienna, Austria, June 21-24 June.
Svensson, J. and Ihlström Eriksson, C. (2009). Challenges with User Involvement in a Living Lab context. In <i>Proceedings of eChallenges 2009</i> , Istanbul, Turkey, October 21-23.
Ihlström Eriksson, C., Åkesson, M., and Svensson, J. (2009). Living Labs: Dilemmas of an Active Researcher. In <i>Proceedings of eChallenges 2009</i> , Istanbul, Turkey, October 21-23.
Ihlström Eriksson, C. and Svensson, J. (2009). Co-creation in Living Labs - Experiences from Halmstad Living Lab. Presented at the INTERACT workshop "Towards a Manifesto for Living Lab co-creation", Uppsala, Sweden, August 24.
Bergvall-Kåreborn, B., Ihlström Eriksson, C., Ståhlbröst, A., and Svensson, J. (2009). A Milieu for Innovation: Defining Living Labs. In <i>Proceedings of the 2nd ISPIM Innovation Symposium</i> , New York City, USA, 6-9 December.
Ihlström Eriksson, C. and Svensson, J. (2008). How to predict the future of an IT innovation? – Examining Pre-adoption of the e-newspaper. In <i>Proceedings of IRIS'31</i> , Åre, Sweden, August 10-13.
Lindqvist, M., and Svensson, J. (2007). Mobile Multimedia Services - Strategy to attract young audiences? In <i>Proceedings of IRIS'30</i> , Tampere, Finland, August 11-14.
Ihlström Eriksson, C. and Svensson, J. (2007). The Mobile e-newspaper Innovation - examining the pre-adoption phase. Presented at LA Global Mobility Round Table, Los Angeles, California, United States, May 31-June 2.
Ihlström Eriksson, C., Åkesson, M., Svensson, J., and Fredberg, T. (2006). Audience view on new technology for media consumption. In <i>Proceedings of the International Workshop on Consuming Audience</i> , Copenhagen, Denmark, September 29-30.
Ihlström, C., Svensson, J. and Åkesson, M. (2005). Participatory Design of Future Every Day IT Artifacts - Engaging readers and publishers in designing the e-newspaper. In <i>Proceedings of the IRIS'28</i> , Kristiansand, Norway, August 6-9.
Ihlström, C., Svensson, J. and Åkesson, M. (2005). How would you like your e-newspaper? - converging the best of two worlds. In <i>Proceedings of HCI International 2005</i> , Las Vegas, Nevada, United States, July 22-27.
Ihlström, C., Svensson, J. and Åkesson, M. (2005). Designing the Future e-newspaper - the da Vinci Approach. In <i>Proceedings of HCI International 2005</i> , Las Vegas, Nevada, United States, July 22-27.

**Table 6.** Additional research papers related to the research question

## 6. Research Contributions

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This section presents the research contributions of the thesis divided into two parts. The first part concerns empirically derived insights regarding categories of network activities that address socio-technical challenges with digital innovation. The second part is a proposed model of how these activities can be orchestrated in digital innovation. This model is based on the findings from literature presented in section 3, which are synthesized and contextualized to digital innovation via empirical findings. The model illuminates the logic behind the categories of network activities as well as their internal relationships. As such, the model addresses my research question concerning how network activities can be orchestrated in digital innovation.

### 6.1 Four Categories of Network Activities in Digital Innovation

In this thesis, four socio-technical challenges with digital innovation have been identified: (a) *initializing and sustaining digital innovation networks*, (b) *translation of diverse and boundary-spanning IT knowledge*, (c) *authenticating value*, and (d) *co-creating value*. These identified challenges are a result of the specific characteristics of digital technology (see section 3.4). In the following subsections, four categories of network activities are presented which address these socio-technical challenges.

#### 6.1.1 Supporting Flexible Innovation Networks

The modular and layered architecture of digital technology typically requires actors with diverse knowledge bases to come together and cooperate to ideate, develop, and implement digital innovations (Yoo et al., 2009; Tilson et al., 2010; Yoo et al., 2012; Kallinikos et al., 2013). As explained in paper 4 and 5, this also occurred in the DigiNews and the Smart Lock cases. In these networks, actors from different fields, with diverse knowledge and assets relating to each of the architectural layers, joined forces.

In both cases, the different roles, agendas, and interests of the involved actors challenged the initialization of the innovation networks. In DigiNews, one hub actor was mainly responsible for initializing the innovation network and mobilizing actors from the different architectural layers of the envisioned e-newspaper. Already from the beginning, it became evident that device producers and content providers did not have a clear picture of their different roles in the envisioned digital innovation. Device producers were interested in aggregating content from the newspapers, whereas the newspapers wanted a device to carry their content, whilst still owning the relationships to advertisers and readers. Different interests in the device itself, e.g. text to speak features, were the main focus of some involved actors, whereas other actors only focused on security solutions relating to e-commerce features enabled by the e-newspaper (Paper 4).

Similar findings were also displayed in the Smart Lock case. In this case there were three actors initializing the innovation network. Even so, different interests and agendas were not clearly communicated when the network was initialized. This resulted in problems sustaining

the relationships in the network during the ideation and development of the digital innovation at hand (Paper 3; 5). In DigiNews there were also issues relating to sustaining the innovation network. Some actors left the initial innovation network as a result of problems concerning the innovation appropriability and value network configuration (Paper 4).

Paper 5, which is based on the Smart Lock case, illustrates the interplay between digital technology and innovation network dynamics with a continuous ebb and flow between malleable and crystallized phases driven by generativity. During malleable phases, actors with complementary expertise within each architectural layer need to be involved to enable a crystallization of the digital innovation at hand. During crystallized phases, an innovation network stabilizes and provides a foundation for further malleability. The empirical findings also suggest that generativity spawned from the architectural layers leverage digital innovation, as long as the innovation network allows for flexibility in terms of reconfiguration of roles and relationships (Paper 5). This highlights the need for flexible innovation networks in digital innovation, e.g. networks that support both change and stability (Tilson et al., 2010, Eaton et al., 2015).

Paper 3 presents network activities that were conducted in the Smart Lock case to initialize the innovation network and establish relationships. Social aspects such as trust, power, and commitment are important to be aware of and facilitate in a digital innovation. These social aspects need to be addressed in network activities in order to enable the creation, facilitation, and possible changes in relationships. The need for a change in a relationship is related to whether innovation potential is sought after or if exploitation of knowledge is the primary aim with a relationship (Paper 3). Similar findings were found in the DigiNews case (Paper 4). In this case it became evident that there were conflicting interests between the technology providers and the service and content providers that needed to be handled during the ideation, development and the implementation of the e-newspaper.

Based on these insights, network activities to align actors' interests and motives are suggested to be conducted continuously during an innovation process. However, it is especially important to communicate actors' interests and motives when new actors join an innovation network (Paper 2; 4). As described in paper 2 and 5, network activities were conducted in the Smart Lock case that supported and facilitated the alignment of motives and perspectives by providing a common ground, or a trading zone (Boland et al, 2007). This was primarily done in the initialization of the innovation network to establish the cooperation between actors.

In the DigiNews case, network activities to align motives were challenging. It was hard for the involved actors to move away from existing paths of innovation, and align their motives with each other. As presented in paper 4, it seems like problems relating to alignment of motives and interests, e.g. to find new ways of collaborating and being flexible in order to act on identified user values, might be one of the reasons behind the initial problems with the e-newspaper innovation. This finding is also corroborated by literature stating that dif-

ferent interests typically result in unsuccessful innovation implementations and that innovation capacity cannot be reaped unless interests are aligned (Obstfeld, 2005; Ahuja, 2000).

Finally, to support and sustain an innovation network, I suggest that a detailed view of the digital technology's architecture is created early on in the ideation of a digital innovation. In the two cases studied, this has been done by using several different methods to blueprint digital technology. For example, service design tools such as service blueprinting, but also business model canvases were used to align interests and motives and map out value propositions and value network configurations. Furthermore, by using these tools, actors necessary to realize a digital innovation can be identified (Paper 4; 5).

To summarize, table 7 presents examples of network activities which are based on empirically derived insights on how to support flexible innovation networks.

Supporting flexible innovation networks
Establish tangible visions of the digital innovation at hand that highlight the layered architecture of the digital technology
Blueprint the vision of the digital innovation detailing the sought after IT knowledge and resources at each of the architectural layers
Identify IT knowledge and resource gaps that need to be researched or bridged by mobilizing and involving actors in the innovation network
Illuminate enrolled actors' different goals, interests, and agendas by collaboratively elaborating on the digital innovation vision whilst continuously shifting perspectives between business, technological, and user/consumer perspectives
Maintain a flexible and dynamic innovation network, with formal and informal relationships, where actors can be involved (and excluded) over time

**Table 7.** Network activities that support flexible innovation networks

### 6.1.2 Production and Translation of Layered Architectural Knowledge

When actors associated to the different architectural layers of digital technology are mobilized into innovation networks, it creates heterogeneous knowledge bases (Boland et al., 2007; Yoo et al., 2010a; Yoo et al., 2012). It is challenging to make sense of unique knowledge brought into digital innovation by diverse actors with different knowledge backgrounds (Boland et al., 2007; Yoo et al., 2009). If one can find ways of connecting, translating and exchanging knowledge between heterogeneous actors, digital innovation will have a higher chance to occur (Yoo et al., 2009). Therefore, to be able to harvest the fruit of the knowledge diversity of involved actors, knowledge translation and exchanges have to be supported. This can be illustrated in both cases where challenges related to the translation of diverse and boundary-spanning IT knowledge were identified. However, the cases also highlighted some activities that successfully translated IT knowledge between heterogeneous actors involved in the innovation network. Furthermore, the two cases provided some insights concerning the production of knowledge within the networks.

In DigiNews, the sheer amount of actors involved did in itself challenge the network activities that aimed to translate and exchange knowledge. As presented in paper 4, the innova-

tion network initialized in DigiNews consisted of 24 actors from nine European countries. These actors represented industry, SME, research labs, and academia. Most actors, except some of the academic partners, could be clearly associated to one of the architectural layers of the digital technology involved in the e-newspaper vision. Their knowledge basis could also be categorized as highly diverse.

This heterogeneity inhibited translation and exchange of knowledge (Paper 4). Many actors did not recognize the need or importance for translated knowledge and disregarded it as more or less irrelevant for their own activities. For example, the engineers working with the e-paper device did not fully recognize the result of the user studies. Instead they focused on developing the initial vision of the digital newspaper and solving technical issues in order to be first on the market. As a result, an exchange of knowledge did not take place. This led to several usability problems, missing features, and an overall problematic device carrying the e-newspaper (Paper 4).

Similar problems were identified in the Smart Lock case. However, the network activities to translate and exchange knowledge were more successful in this case. As presented in paper 2, a multitude of activities were conducted to translate knowledge between researchers, different user communities, and the firms involved in the innovation network. As illustrated in both cases, as well as in related literature (Boland et al., 2007; Yoo et al., 2009; Tiwana et al., 2010), actors with diverse IT knowledge need to translate and exchange knowledge over organizational boundaries in order to enable digital innovation capacity.

As shown in the individual papers, network activities that utilize boundary objects can translate and exchange knowledge successfully between heterogeneous actors (Paper 1; 2; 4). Examples of boundary objects that were used in both cases were personas, use scenarios, mock-ups, and prototypes. The network activities that utilized boundary objects included workshops with different user and consumer groups. In these workshops mock-ups, scenarios and personas were created based on users' different needs and requirements. Design solutions and concepts, as well as user descriptions in the shape of e.g. personas, were then presented for developers who incorporated the knowledge into mock-ups, and prototypes. These iterative activities also provided involved actors with a better understanding of conflicting interests in the heterogeneous audience of the innovations.

The boundary objects created in these network activities worked as a way to represent and integrate knowledge between heterogeneous actors as described by Boland and Tenkasi (1995). The objects acted as mediators between different actors with different knowledge basis (Boland et al., 2007). Boundary objects therefore help translate, bridge, and exchange knowledge between different actors involved, something that is also shown in the two cases (Paper 1; 2; 4).

Deciding which boundary objects are suitable to use is dependent on the actual context of the innovation and the involved actors. However, by increasing the variety of boundary ob-

jects used, the accuracy, range and nature of knowledge exchanges can be improved (Carlile, 2002). It is therefore suggested to use a multitude of different objects to support successful knowledge exchanges and translations of knowledge into prototypes.

The cases also highlight some activities that relate to the production of layered architectural knowledge within the innovation networks. In both cases knowledge was produced by a multitude of actors. For example, technology firms and academic partners conducted traditional internal R&D to develop layered architectural knowledge necessary for the digital innovations at hand. The outcome of the combined efforts of these involved actors created, for example, knowledge relating to production, distribution, and the display of different content. This development of knowledge then led to a deeper understanding of vital technology, e.g. sensor technology, digital radio and network technology, and screen technology. The academic partners also conducted market investigations and user studies to produce knowledge about consumer behaviors, needs, and requirements as well as facilitating user generated ideas and prototype to address these needs (Paper 1; 4; 5).

Layered architectural knowledge was also produced in other ways. For example, in the Smart Lock case the initializing actors made a knowledge inventory to identify what knowledge was missing to realize the vision of the digital innovation. This knowledge was then either brought into the network by involving another actor, or by e.g. incorporating existing technology in the shape of displays or circuit boards with certain sought after functionality. Furthermore, CAD knowledge and 3D printing were incorporated in the development of the digital innovation via consultants.

To summarize, table 8 presents examples of network activities which are based on empirically derived insights on how to produce and translate layered architectural knowledge.

<b>Production and translation of layered architectural knowledge</b>
Research identified knowledge gaps
Facilitate the production of knowledge over organizational boundaries
Work collaboratively with translation activities to support IT knowledge and perspective exchange between actors
Involve representatives from all actors (including users and consumers) to translate IT knowledge from different layers of digital technology with the help of boundary objects

**Table 8.** Network activities that produce and translates layered architectural knowledge

### 6.1.3 Addressing Heterogeneous User Communities

The generativity of digital technology enables unbounded opportunities for digital innovations leveraging value to consumer markets (Zittrain, 2006; Yoo et al., 2010a; Tilson et al., 2010). Digital innovations are generative leading to adaptable and malleable products and services (Zittrain, 2006; Yoo et al., 2010a; Yoo et al., 2012). This malleability and adaptability typically creates a need for continuous authentications of consumer value when developing



digital innovations (Paper 1; 4). Generativity of digital technology also leads to large and diverse user and consumer communities (Zittrain, 2006; Yoo et al., 2010a; Yoo et al., 2012). As illustrated in the two cases, this creates specific challenges in relation to identifying and authenticating user values which in themselves can be as malleable as digital technology (Paper 1; 4).

In DigiNews, a multitude of services and technological features were included in the vision of the e-newspaper. There were also several suggestions of network technologies to support the needs for mobile updates and context aware services. During the ideation, development and implementation of the e-newspaper, these services and features were changed or eliminated, and new ones were suggested continuously. Some of these changes were a result of technological feasibility, some due to changes in the innovation and value network, and some due to findings in relation to the involvement of users and consumers (Paper 1; 4). As presented in paper 3, and highlighted in paper 5, the Smart Lock case also involved multiple changes in the different architectural layers of the digital innovation. A majority of these changes were a direct result of the network activities involving users to help harness the generativity of the technology (Paper 3; 5).

The two cases also highlight different user and consumer communities' needs and requirements (Paper 1). These heterogeneous user groups challenge the view of the user and the use of traditional ways of user involvement in digital innovation (Paper 1). Diverse needs and requirements can be related to the architectural layers of the digital technology involved. Not only did the different groups require different content and services, but there were also differences concerning the usage of devices and networks. For example, even though the same services were used by seniors, their next of kin, and health care personnel in the Smart Lock case, their interests, wants, and needs were highly diverse. This required an involvement of all user communities in the innovation network to successfully gather insights about services and features. The need for user and consumer involvement was also required to identify the value proposition for the different communities. This was also the case in DigiNews where newspaper staff with different tasks within the organizations, advertisers, as well as diverse groups of readers, was involved to gather the complex and diverse requirements from different user and consumer communities.

To address the challenges with authenticating value, a modified way of customer involvement in digital innovation is suggested in paper 1. In this paper, a multitude of activities and techniques to involve audiences throughout the digital innovation process are suggested. The presented techniques are quite traditional (e.g. workshops, interviews, observations, questionnaires), however, the techniques are categorized based on what type of information is sought after and where in the innovation process you are. Furthermore, paper 1 divides the activities based on which types of users are involved.

The cases also highlight some network activities to address challenges with authenticating user and consumer value provided by digital innovations. To be able to implement innova-

tions that leverage user value, it is important to identify and validate these values (Eriksson et al., 2005; Rosted, 2005; von Hippel, 2005; Yoo, 2010; Boztepe, 2007). To enable the authentication of value, iterative evaluations need to be conducted as soon as new artifacts such as prototypes are developed. As described in the DigiNews case, iterations of prototype tests and evaluations enabled the innovation network continuous insights regarding key user values (Ihlström Eriksson and Svensson, 2009).

Both cases show the importance of conducting real life evaluations of digital innovations to authenticate key user values. The real life tests conducted provided a rich picture of the involved users' opinions, drivers and behaviors compared to those gathered by traditional evaluations. This authentication also provided valuable data concerning design and business aspects of the innovation (Paper 1). By conducting the authenticating activities during an extended period of time, changes in the involved users' impressions could also be identified.

Based on these insights, I therefore suggest that innovation networks incorporate real life authentication activities that identify, evaluate, and authenticate the value of digital innovations. To summarize, table 9 presents examples of network activities addressing heterogeneous user communities based on empirical insights.

Addressing to heterogeneous user communities
Continuously involve relevant categories of users/consumers to identify, evaluate, and authenticate values in relation to the opportunities of the digital innovation at hand
Complement traditional categories of organizational users with categorizations of diverse consumer communities to enable the identification of relevant users/consumers to be involved
Identify key values for different types of users by researching their different perspectives
Incorporate identified key values directly into prototypes for evaluation and authentication
Conduct real life evaluations during extended periods of time to identify consumer demands

**Table 9.** Network activities that address heterogeneous user communities

#### 6.1.4 Harnessing Generativity to Leverage Value

The generativity of digital technology leads to dynamic and malleable value networks. To support innovation appropriability and co-creation of value in digital innovation, value network configurations need to be flexible (Åkesson, 2009; Tilson et al., 2010). This requires both an innovation network that can change, whilst still being stable enough to support actors' innovation appropriability (Dhanaraj and Parkhe, 2006). The sought after flexibility of innovation networks in digital innovation creates issues relating to control and power (Tilson et al., 2010; Eaton et al., 2015).

Harnessing generativity to reach innovation appropriability is challenging in digital innovation, which can be illustrated in the DigiNews case. As Philips was the device producer, initiator of the innovation network and a hub actor who managed the project, their views and interests were dominant. This created problems and led to commitment issues from some actors involved. For example, newspapers did not agree on the initial business model and

the proposed value network configuration as it embodied a conflict of business interests (Paper 4).

Several conflicting interests were identified between the involved actors in the DigiNews case. For example, industry actors and SME actors in the innovation network had different goals and agendas. The SMEs had narrow interests relating to their profiles and competences, while industry actors had a wider perspective of what features and services they could provide, and how they could create value in relation to an e-newspaper. Even so, the involved firms struggled somewhat to move away from existing innovation paths and align interests to find new value network configurations and business models. The heterogeneity of the involved actors, who had different interests relating to the different architectural layers of the e-newspaper, inhabited the innovation appropriability.

A way to address these challenges in the Smart Lock case was to create transparency and focus on communicating actors' interests and agendas. This transparency also mitigated problems relating to setting up flexible value network configurations that supported innovation appropriability. An example of an activity that provides transparency is service and value blueprinting. Service and value blueprints help facilitate discussions between actors concerning which design features and services create value at different architectural layers of a digital innovation. Such blueprints illuminate different actors' roles and agendas in the development and implementation of digital innovations. They therefore have the potential to explicitly address actors' interests, and communicate them between actors in innovation and value networks.

As presented in paper 2, one way of supporting co-creation of value is also to establish trading zones. In trading zones, actors with different knowledge, interests, and agendas can meet and negotiate and learn from each other (Boland et al, 2007). The negotiation of interests and the interplay between the actors, supports the alignment of perspectives while striving for innovations providing innovation appropriability for the involved partners (Dhanaraj and Parkhe, 2006; Yoo et al., 2009). Trading zones also strengthen the absorptive capacity of involved actors in an innovation network (Garud et al., 2013; Mowery et al., 1996; Cohen and Levinthal, 1990). By utilizing external knowledge, new insights can be gained and enable firms to address new opportunities relating to market demands (Teece et al., 1997). In the Smart Lock case, trading zones were established by facilitating meetings and discussions that explicitly addressed all involved actors' interests and agendas before initializing the innovation network.

Generativity of digital innovations create unbounded opportunities for providing services and features. One way to harness this generativity is to actively involve users to guide the ideation, development, and implementation of digital innovations. However, to be successful, all involved actors in an innovation network need to be able to capture value generated by a digital innovation. Therefore, generativity of digital innovations also needs to be harnessed to reach innovation appropriability. This includes network activities that harness

generativity into features and services that provide equitably distributed value between actors. Furthermore, these activities need to create trust as well as supporting social interaction between network actors (Dhanaraj and Parkhe, 2006). This can be challenging as illustrated in paper 3 and 4. Based on these insights, there is a need for network activities which facilitates ongoing discussions between actors to establish their roles in the value network. To facilitate these interactions, either a perceived neutral partner could be involved as a mediator (Paper 2; 3), or a strong hub actor could orchestrate these network activities which supports innovation appropriability (Dhanaraj and Parkhe, 2006).

To summarize, table 10 presents examples of network activities which are based on empirically derived insights into how to harness generativity.

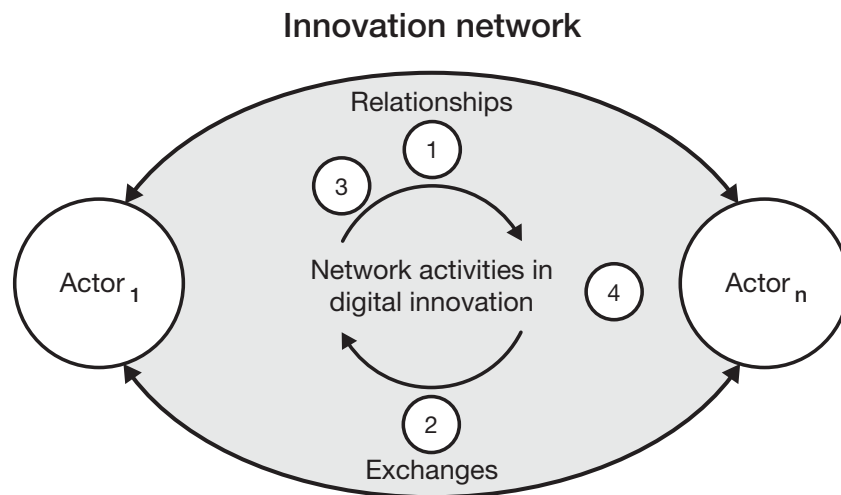
Harnessing generativity to leverage value
Establish tangible visions of the digital innovation at hand that highlights the value network configuration
Blueprint the vision detailing which actor provides what value to whom and detail how this value proposition is enabled by the architecture of the digital innovation
Facilitate the alignment of actors' interests to enable the development of value network configurations and business models supporting the digital innovation at hand
Facilitate ongoing discussions between actors to establish their roles in the value network
Enable trading zones which support actors from different architectural layers to co-create value and present competitive value propositions which meet market demands

**Table 10.** Network activities that harness generativity to leverage value

### 6.1.5 Summary: Network Activities in Digital Innovation

Section 6.1 provides empirical examples of how socio-technical challenges were either successfully or unsuccessfully addressed and what implications this resulted in. A total of 19 examples of network activities which address the socio-technical challenges within digital innovation have been presented. Some of these examples are a result of empirical observations, while some are syntheses derived on theoretical as well as empirical insights. The examples should not be seen as generic or tentative solutions. Instead they should be seen as a way to understand the four categories of network activities which need to be orchestrated in digital innovation.

The conceptual model of network activities in digital innovation presented in section 3.3 (Figure 1) provides a foundation for understanding the four categories of network activities in digital innovation. In Figure 5, the conceptual model is used to relate the different theoretical notions presented in the literature review to the four categories of network activities.



**Figure 5.** Categories of network activities in relation to the conceptual model

The first category of network activities labeled (1) represents *supporting flexible innovation networks*, is essential to balancing change and control in a way that leverages value and innovation appropriability for the actors involved in an innovation network. In other words, supporting flexible innovation networks is important to establishing and nourishing successful relationships between actors in digital innovation networks. The second category of network activities labeled (2) represents *production and translation of layered architectural knowledge*, is related to the exchange of knowledge between actors. Within this category there are network activities to produce, translate and exchange knowledge between actors. Knowledge is key to ideating, developing, and implementing digital innovations. The third category of network activities labeled (3) represents *addressing heterogeneous user communities*, primarily relates to building relationships with user and consumer communities to identify, evaluate, and authenticate values in relation to a digital innovation. The fourth category of network activities labeled (4) represents *harnessing generativity to leverage value*, is related to both relationships and exchanges between actors involved in an innovation

network. The network activities in digital innovation related to this category include establishing and supporting value network relationships as well as exchanging perspectives between actors to align interests. Finally, these categories of network activities need to be orchestrated in a manner that they support the ideation, design, development, and implementation of digital innovations.

To understand how network activities can be orchestrated in digital innovation, a discussion concerning the interrelationship between the categories of activities is needed. Furthermore, there is a need to elaborate on the logic behind the orchestration process. The next subsection presents a discussion based on these two topics.

## 6.2 Orchestration of Network Activities in Digital Innovation

This subsection presents a model of how network activities can be orchestrated in digital innovation. As such, it represents the main contribution to the thesis. The model is based around the four suggested categories of network activities: (1) *Supporting flexible innovation networks*, (2) *Production and translation of layered architectural knowledge*, (3) *Addressing heterogeneous user communities*, and (4) *Harnessing generativity to leverage value*.

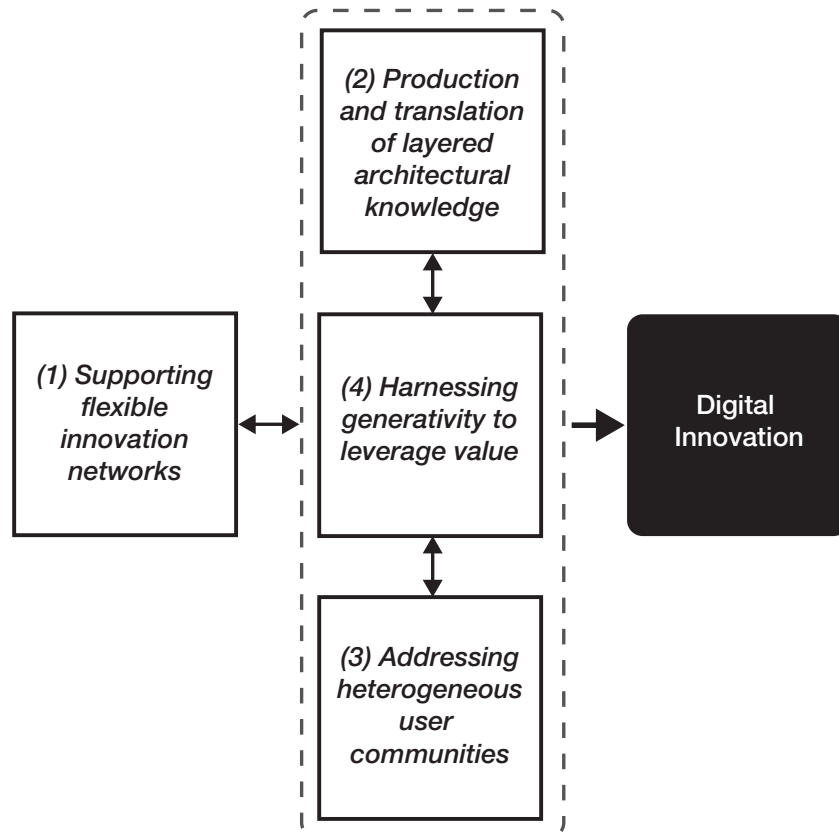
(1) *Supporting flexible innovation networks* corresponds with the network activity “support stable networks” suggested by Dhanaraj and Parkhe (2006). However, in digital innovation there is a need for flexible networks rather than stable ones (Paper 3; 4; 5). In traditional innovation networks, stability is an important aspect to support sufficient value creation for involved actors (Dhanaraj and Parkhe, 2006). However, in digital innovation, the networks need to support a continuous ebb and flow between malleable and crystallized phases of digital innovation driven by generativity (Paper 5). These two phases require different knowledge and resources, which typically calls for flexible networks during malleable phases and stable networks during crystallized phases of digital innovation (Paper 5). This requirement for flexibility is also highlighted in paper 3 where different relationships and knowledge exchanges were needed in different phases of the digital innovation process. The necessity for flexible innovation networks in digital innovation is also highlighted in related literature (Åkesson, 2009; Tilson et al., 2010, Eaton et al., 2015).

(2) *Production and translation of layered architectural knowledge* corresponds with the network activity “knowledge mobility” suggested by Dhanaraj and Parkhe (2006) as well as “production of knowledge” and “translation of knowledge into working artifacts” suggested by Pavitt (2006). However, by identifying that knowledge is related to the layered architecture of digital technology, this category of activities is contextualized to digital innovation. By illuminating that knowledge typically needs to be produced at all architectural layers (Paper 4; 5), insights can be made regarding network activities in digital innovation (Paper 4). Furthermore, by understanding the importance of the knowledge at each of these layers, network activities concerning the translation of knowledge become apparent (Paper 2). As illustrated in both cases, boundary objects can translate and exchange knowledge successfully between heterogeneous actors in digital innovation (Paper 1; 2; 4). These findings were also

corroborated in related literature (Boland and Tenkasi, 1995; Carlile, 2002; Boland et al., 2007).

(3) *Addressing heterogeneous user communities* corresponds with the activity “responding to and influencing market demand” suggested by Pavitt (2006). Traditionally, this activity in innovation concerns how to match developed artifacts with market demands and needs. This is also the case in digital innovation, however as presented in paper 1, the heterogeneity of users and consumers of digital innovations creates challenges. Traditional ways of categorizing and involving users is not ideal in digital innovation. For example, Paper 1 highlights the need to involve users and consumers with different perspectives and interests in relation to a digital innovation. Furthermore, the heterogeneity of the involved users requires considerations of the composition of user groups as well as identifying motivational factors to keep involved users dedicated (Paper 1). As illustrated in the two cases, it is important to engage users and consumers to identify needs and values, as well as continuously authenticate these needs and values to be able to successfully respond to heterogeneous market demands (Paper 1; 3; 4). This is also corroborated in related literature (Eriksson et al., 2005; Rosted, 2005; Boztepe, 2007; Yoo, 2010).

(4) *Harnessing generativity to leverage value* corresponds with the network activity “innovation appropriability” suggested by Dhanaraj and Parkhe (2006). Innovation appropriability is an important network activity which concerns actors’ ability to capture value generated by an innovation (Dhanaraj and Parkhe, 2006). This is naturally also the case in digital innovation. However, at least two explicit differences compared to traditional innovation contexts can be discerned. Firstly, the malleability and adaptability of digital innovations can quickly and dramatically change how involved actors can capture value from an innovation (Paper 3; 5). Therefore, generativity needs to be harnessed in order to reach innovation appropriability by specific network activities. This includes ideating, developing, and implementing digital innovations with features and services that provide equitably distributed value between actors. This is something which can be rather challenging in digital innovation (Paper 3; 4; 5). The second difference relates to the role of a hub actor in traditional innovation networks. As digital innovation is distributed and networked (Yoo et al., 2012; Kallinikos et al., 2013; Eaton et al., 2015), the role of a hub actor influencing innovation appropriability is typically diminished. In digital innovation, more than one actor might be responsible for orchestrating network activities that influence innovation appropriability.



**Figure 6.** A model of orchestration of network activities in digital innovation

As shown in Figure 6, three categories of network activities are coupled. Together they shape the digital innovation as an outcome. Their interrelationship is as follows: (2) harnesses generativity by providing insights into how a digital vision can be realized into a digital innovation. (3) also provides insights into how to harness generativity to leverage user and consumer value. As such, (4) receives input from both of these categories.

As illustrated by the double sided arrows, (4) likewise provides input back into both (2) and (3), for example, (4) guides what needs to be evaluated and authenticated in (3). Furthermore, (4) provides insights into (2), e.g. by highlighting what knowledge needs to be produced and translated between actors in order to realize a digital innovation that provides value for all involved actors, including leveraging user and consumer value.

The three coupled categories of network activities in the middle all influence, and are influenced by (1). Actors from different architectural layers of a digital innovation have to be involved at certain phases. These actors might either need to be involved to produce knowledge (2), or to fill a role in a value network configuration in order to support innovation appropriability (4). Furthermore, network activities relating to (3) create a need for involving user and consumer communities into an innovation network during different phases of digital innovation.

The four categories of network activities can be viewed as building blocks for orchestrating digital innovation. As such, they can be tweaked and configured based on the actual innova-



tion context. They all contribute to ideating, developing, and implementing a digital innovation. However, in what way, and in what order they are orchestrated depends on the digital innovation at hand. They should therefore not be seen as categories of network activities that could be generically planned for and organized in a certain way. Instead, by highlighting orchestration as an approach, the model emphasizes both a proactive and a reactive way of orchestrating digital innovation where the categories often overlap each other or occur in parallel. As such, the model proposes a way to address the ambiguity and complexity of digital innovation.

As this model addresses and elaborates on the internal logic between network activities, it provides deeper insights into the orchestration process compared to the network orchestration framework presented by Dhanaraj and Parkhe (2006). This model does not assume that a hub actor always acts as an orchestrator of network activities conducted in a network. Instead, this role might be distributed in digital innovation. Therefore, more than one actor might be responsible for the orchestration of network activities. The orchestrating role might also change in different phases of digital innovation.

The model also differs concerning the view of the relationship between network design and the orchestration process. In digital innovation, network design is something which is done continuously (Paper 3; 4; 5). Network design is therefore incorporated in the category of network activities concerning the support of flexible innovation networks. This is also a way of highlighting that the process is not linear, i.e. first there are network design activities, and then network activities are orchestrated.

Another difference compared to the framework proposed by Dhanaraj and Parkhe is that this model is contextualized to digital innovation. Not only by changing and adding new categories of network activities that are unique for digital innovation, but also by elaborating how these network activities play out and need to be orchestrated in the specific context of digital innovation.

The proposed model addresses at least three overall challenges with digital innovation described by IS research. Firstly, the model addresses challenges with the networked aspect of digital innovation reported by IS scholars (Yoo et al., 2009; Tilson et al., 2010; Yoo et al., 2012; Eaton et al., 2015). The exemplified network activities within the categories of (1) *supporting flexible innovation networks* and (4) *harnessing generativity to leverage value* highlights ways of addressing these challenges with networked collaboration. For example, how to mobilize and involve heterogeneous actors in innovation networks with conflicting interests and diverse knowledge bases.

Secondly, the model addresses challenges with involving consumers in digital innovation reported by IS scholars (Henfridsson and Lindgren, 2010; Yoo, 2010). The exemplified network activities within the category of (3) *addressing heterogeneous user communities* highlight

ways of addressing these challenges with engaging and involving heterogeneous users to identify needs, values, and experiences.

Thirdly, the model addresses challenges with handling the complexity and ambiguity in digital innovation reported by IS scholars (Yoo, 2010; Tiwana et al. 2010; Tilson et al., 2010; Yoo et al., 2012; Thomsen and Åkesson, 2013). The model itself, including all four categories of network activities, suggests a way of addressing these challenges. As such, the model aims to address challenges relating to how organizations can orchestrate nonlinear, ambiguous, and complex activities in digital innovation aiming at developing digital innovations leveraging user and consumer value (Boland et al., 2007; Yoo 2010; Yoo et al., 2010a; Yoo et al., 2012; Thomsen and Åkesson, 2013).

By providing insights into the four suggested categories of network activities in digital innovation and their internal relations, as well as the overall logic of orchestration as a process, the proposed model addresses this thesis research question concerning how network activities can be orchestrated in digital innovation.

## 7. Conclusions

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In this concluding section, a brief discussion about implication for research and practice is presented. The section is concluded with limitations as well as suggestions for future research.

### 7.1 Implications for Research

Much research within digital innovation has been of a conceptual nature (e.g. Yoo et al., 2010a; Yoo et al., 2012; Svahn and Henfridsson, 2012; Kallinikos et al., 2013). In this stream of research, arguments are made for how digital innovation differs from traditional innovation. This research argues for how the unique characteristics of digital technology are challenging digital innovation. However, little to none of this research actually speaks to how these challenges can be addressed. Instead there are several calls for research to better understand how digital innovation processes can be organized to address the highlighted challenges (Yoo, 2010; Tiwana et al. 2010; Tilson et al., 2010; Yoo et al., 2010a; Yoo et al., 2012; Svahn and Henfridsson, 2012). This thesis is a response to these calls for research by presenting two empirical cases investigating how network activities in digital innovation can be orchestrated. The implications for research are two-fold.

First, the proposed model detailing orchestration of network activities in digital innovation contributes to existing research by explaining the interrelationship between the categories of activities which address the identified challenges, as well as describing the overall logic of the orchestration process. As such, the model presents insights into how network activities in digital innovation can be orchestrated. Furthermore, the proposed model is extending existing research concerning orchestration (Dhanaraj and Parkhe; 2006; Hjalmarsson and Lind, 2011; Levén et al., 2014) by elaborating on the interrelationship between network activities and the overall logic of the orchestration process. Therefore, the model is providing valuable insights into other fields of innovation as well where networked and ambiguous innovation processes take place.

Second, the socio-technical challenges identified in related literature summarize existing knowledge regarding how the characteristics of digital technology challenge digital innovation. This provides a coherent overview of socio-technical challenges with digital innovation compared to existing research (compare to e.g. Yoo, 2010; Tilson et al., 2010; Yoo et al., 2012).

### 7.2 Implications for Practice

The primary implication for practice is the tentative network activities to address the challenges with digital innovation together with the model explaining how these activities can be orchestrated. As such, the model presents a practical way of orchestrating network activities in digital innovation. The categories of activities provide insights into important aspects that need to be addressed in digital innovation. They can therefore be viewed as building blocks for the orchestration process. By emphasizing both a proactive and a reactive way of orches-

trating digital innovation, the model proposes a flexible way for organizations to address the ambiguity and complexity of digital innovation. The practical implications from the suggested categories of network activities are briefly summarized and presented below.

I emphasize the identification of key user values as early as possible in digital innovation to help guide a vision into a digital artifact. This is enabled by different user involvement activities. Furthermore, I suggest that the identified key user values are continuously evaluated and authenticated and used to guide the development and implementation of digital innovations.

Organizations need to orchestrate activities that mobilize innovation actors into innovation networks. This includes the initiation of network relationships which enables knowledge exchanges. To guide these network activities, there is a need to identify knowledge and resource gaps required to realize a digital innovation. There is also a need to illuminate mobilized actors' different goals, interests, and agendas in order to enable transparency which helps sustain a flexible and dynamic innovation network.

Organizations also need to be aware of different needs in malleable versus crystallized phases of digital innovation. To cater to these needs, network activities have to facilitate successful knowledge production and exchange of knowledge. Moreover, there is a need to initiate relationships that support the invention, development, and implementation of digital innovations. Furthermore, knowledge needs to be translated between heterogeneous actors. This includes the translation of IT knowledge within different architectural layers of the digital technology used. This translation of knowledge can be supported with boundary objects.

Finally, to harness generativity to leverage value, there is a need to establish a vision that highlights which actor provides what value and to whom. Furthermore, the network activities must detail how the value is enabled by the architecture of a digital innovation. This is a delicate social process where alignment of actors' interests needs to be facilitated in order to enable the co-creation of value which can be leveraged to user and consumer communities.

### **7.3 Limitations and Future Research**

There are naturally limitations with my study which can be addressed in future research. One is that the context of research is limited to Living Lab. As a result, a similar approach to digital innovation has been studied in both cases with, for example, a high degree of user involvement and active research actors. I therefore suggest that additional studies of digital innovation should be conducted to compare and elaborate the results presented in this thesis.

Another limitation is that the suggested examples of network activities are tentative. These activities, as well as the proposed model of orchestration of digital innovation need to be validated in future studies. This could include research on the effectiveness and efficiency of the model to support the orchestration of digital innovation.

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Furthermore, by deriving challenges with digital innovation from literature, there is a risk that some issues and challenges were not identified. Even though the challenges were instantiated in my cases, there is a risk that the literature provided a way of not seeing other possible challenges. I therefore suggest that a grounded research approach could be utilized to identify additional challenges with digital innovation. Such studies could further inform my model.

Even with these limitations, the proposed model still presents a tangible contribution to the field of digital innovation by providing both theoretical as well as empirical insights concerning how network activities can be orchestrated in digital innovation.

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