# Shared Platform Coopetition:
# The Paradoxical Tension between Stabilized Cooperation and Intensified Competition

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## Abstract

My licentiate dissertation concerns shared platform coopetition in which competitors cooperate to develop technology standards in dynamic technological landscapes. It relies on an historical analysis of a twelve-year (2002-2013) shared platform initiative in the Swedish road transport industry, which led to a new technology standard for integration of stationary enterprise systems with emerging embedded and mobile technologies. Drawing on theories of coopetitive relationships, shared platforms, and technology standards, the objective of the research is to explore the impact of technology architectural shifts on coopetitive dynamics in such initiatives. My overarching research question reads as follows: "What are the dynamics of shared platform coopetition and their respective implications for ecosystem governance strategies?" The findings of my study explicate not only the ways in which such coopetitive dynamics unfold, but also how governance to reduce resource heterogeneity may culminate in intensified competition between cooperating actors after a technology standard has emerged. Based on these findings, I contribute to the platform literature by discussing the nature of the coopetitive dynamics that characterize shared platform initiatives where emerging technology architectural shifts challenge their governance strategies. In addition to these theoretical insights, my dissertation offers implications for platform leaders who seek to nurture innovation in their ecosystems.

**Keywords:** Shared platforms, coopetitive relationships, technology standards, architectural shifts

## Introduction

Prior research suggests there are two theoretical perspectives on digital platforms (Gawer 2014). The economic point of view sees platforms as double-sided markets and has yielded insights on platform competition (Eisenmann et al. 2011). The engineering perspective views platforms as technological architectures and has focused on platform innovation (Boudreau 2010). These perspectives are rooted in different intellectual traditions with distinct assumptions and they have therefore focused on various directional forces that platforms respond to. Consequently, they have not helped to explicate how platform competition and platform innovation interact. These forces cannot be understood in isolation because in reality they interact to shape the evolution of platforms with their ecosystems

and/or across ecosystems (Gawer 2014; Tiwana 2015; Wareham et al. 2014). That is, platforms often evolve in ways that combine innovation with increased competition that renders paradoxical tensions. There is therefore a need for integrative studies of "shared platform coopetition" and the governance strategies enacted by platform leaders to nurture their ecosystems (Eisenmann 2008; Gawer 2014; Wareham et al. 2014). Indeed, such studies have to be sensitive to dynamic technological landscapes where emerging technology architecture shifts render consequences for coopetitive dynamics (Afuah 2000; Afuah 2004; Bouncken et al. 2010).

Shared platforms, i.e., consortia that collaboratively design and manage technological infrastructures and rules that regulate the interactions among industry players, are often fraught with challenges. In particular, participating firms have to be convinced continuously of the platform's value, while their position vis-à-vis competitors and complementors dynamically shifts as its architecture and rules evolve. My research explores the evolution of shared platform coopetition in dynamic technological landscapes where competitors cooperate to develop technology standards. Given this focus, I identify and conceptualize the paradoxical tension (Lewis 2000) between stabilized cooperation and intensified competition, which I empirically examine through a twelve-year (2002-2013) historical analysis (Mason et al. 1997b) of a shared platform initiative in the Swedish road transport industry. In particular, I seek to explicate not only the ways in which coopetitive dynamics unfold in such settings, but also how governance to reduce resource heterogeneity may culminate in intensified competition between actors, especially after a technology standard has emerged and cooperation within the industry has been stabilized. Indeed, academics and practitioners alike benefit from a better understanding of the nature of this tension and its potential consequences for ecosystem governance strategies.

I rely specifically on theories of coopetitive relationships, shared platforms, and technology standards which provides me with an initial lens to explore the impact of technology architecture shifts on coopetitive dynamics in shared platform initiatives that integrate heterogeneous technologies by developing new technology standards. My overarching research question reads as follows: What are the dynamics of shared platform coopetition and their respective implications for ecosystem governance strategies?  The findings of my study explicate not only the ways in which such coopetitive dynamics unfold, but also how governance to reduce resource heterogeneity may culminate in intensified competition between cooperating actors after a technology standard has emerged. Based on

these findings, I contribute to the platform literature by discussing the nature of the coopetitive dynamics that characterize shared platform initiatives where emerging technology architectural shifts challenge their governance strategies. In addition to these theoretical insights, my dissertation offers implications for platform leaders who seek to nurture innovation in their ecosystems.

## Theoretical Review

The economic perspective conceptualizes digital platforms as double-sided markets (Eisenmann et al. 2011). Here a digital platform is understood as a mediator between different actors whose only transaction conduit is the platform. Taking into account its socio-technical structure is key to comprehensively understand the ways in which it evolves over time (Gawer 2014).

Shared platforms are consortium of firms that set standards, share infrastructure costs and rely on a common platform to communicate with each other (Eisenmann 2008). These platforms are an increasingly common organizational form as firms seek to develop industry-specific interoperability through standardized interfaces. Cargill (2002) highlights that consortia, composed of industrial players interested in solving a particular problem (rather than traditional standard development organizations such as the ISO) are increasingly creating standards for the IT industry. Furthermore, Yates and Murphy (2014) point out that most industry standards are developed by private standard setting organizations (rather than government regulators or individual firms) and adopted voluntarily (rather than mandated). This suggests that generating insight into the emergent organizational forms that are shared platform is important.

Even though Le Masson et al (2011, p. 273) note that "surprisingly little research has been done on [shared] platform design and the collaborative relationships involved", there is nevertheless considerable research on the cooperative development of the standards that form a necessary part of a platform's infrastructure. This research on "voluntary consensus standards setting processes" (Yates and Murphy 2014) examines such questions as how market power and intellectual property rights impact the resulting standard (e.g., Bekkers et al. 2002; Rysman and Simcoe 2008), the importance of the working group's chairperson's technical expertise and personal networks within the standardization consortium (e.g., Fleming and Waguespack 2007), and the role of cooperative relations outside

of the standard development organization in the standard-setting outcome (e.g., Leiponen 2008). Also, Zhao et al (2007) develop a three-stage process model of consortium-based standardization in which they highlight the trade-offs participating firms face as they decide whether to take part in the consortium, actively engage in the development, and adopt the resulting standard. Schilling (2009) looks into different pathways to achieve dominant design, different technology strategies and different control mechanisms in standard making in technology platforms.

However, most of this research on collaborative standardization emphasizes social factors (e.g., knowledge assets and relationships between actors) and fails to consider the role that technology (e.g., architecture) plays in the process and its outcomes. This is problematic because changes in the technology's infrastructure have implications for the relationships among participants engaged in the development of the platform standard (Gawer 2014).

Baldwin and Woodard (2009) define such structure as a modular technological architecture that consists of stable core components complemented by variable periphery components. Interfaces and/or protocols facilitate communication between these components within a standardized architecture (Langlois 2002; Langlois and Robertson 1992). Indeed, their mediating role is even more important when a digital platform is open and generativity is of particular concern (Boudreu 2010), because they serve as architectural control points between modules and layers (Baldwin 2008; Baldwin and Woodard 2009; Wareham et al. 2014). As such, by helping platform owners to control granting access to complementors, these interfaces/protocols provide a key governance mechanism to reconcile paradoxical tensions in shared platform initiatives (Wareham et al. 2014). Such governance is necessary to involve actors who take different sides of a digital platform, thus contributing to its overall performance and positive progression (Hagiu and Wright 2011). While there have been studies of this type of actor involvement, however, most of them concern rather homogenous platform situations. This is unfortunate because shared platform initiatives in many industries often rely on heterogeneous milieus characterized by actors who simultaneously engage in cooperation and competition (Wareham et al. 2014).

Indeed, shifting coopetitive relationships between diverse actors affect the technology architecture of the platform and vice versa. There is therefore a need for studies that carefully scrutinize such intricate socio-technical dynamics with the ambition to contribute to the understanding on the ways in which platform competition and platform

innovation interact over time. A useful theoretical lens for such endeavors is Gawer's (2014) integrative framework in that it puts the actors of a platform initiative center stage. More specifically, it conceptualizes platforms as evolving organizations or meta-organization that: 1) entail a modular technological architecture (i.e., composed of a core and a periphery); 2) coordinate constitutive actors who can compete and innovate (i.e., engage in coopetitive dynamics); 3) create value by generating and harnessing economies of scope in supply or/and in demand.

Competition during platform innovation processes emerges usually through technology architecture shifts (Gawer 2014; Wareham et al. 2014; Saadatmand and Lindgren 2016). At the same time, cooperation between stakeholders of different structural types, typically having diverging interests, is key to leveraging platform performance (Eaton et al. 2015; Wareham et al. 2014).  Such cooperation is, however, impossible without managerial interventions (Saadatmand and Lindgren 2016). This points to the centrality of proper governance of technological platforms and their ecosystems. That is, the platform leader should seek to preserve the alignment of interests of ecosystem members to increase their incentives to innovate in platform enhancing ways (Gawer 2014; Wareham et al. 2014). Here one pressing issue concerns the establishment of coopetition among actors, leading to concurrent cooperation and competition (Hargrave and Ven de Ven 2006; Bengtsson and Kock 2000).

If a firm has come to depend on its coopetitor's capabilities, however, obsolescence of their capabilities can also result in lower performance for the firm. That is, collaborative relationships with coopetitors, which are usually a source of competitive advantage, can become a handicap when a technology architecture shift renders coopetitors' capabilities obsolete (Afuah 2000). This means firms ought to pay attention not only to the impact of the shift on their capabilities, but also to the impact of the shift on their coopetitors (Afuah 2004).

Coopetition is a concept coined for framing situations where cooperation and competition occur simultaneously (Bengtsson et al. 2010; Bengtsson and Kock 2014; Chen 2008; Nalebuff and Brandenberger 1996). It breaks therefore with the traditional assumption that relationships between firms are either cooperative or competitive in nature (Walley 2007). Viewing cooperation and competition as a duality rather than a dualism has proven to be a powerful strategy for theorizing collective action in firm networks (Tsai 2002) as well as inter-firm networks (Bengtsson and Kock 2000). However, the literature on cooperation has evolved almost independently from the literature on competition, which means that the intricate interplay between cooperation and competition is still largely

under-researched (Hoffmann et al. 2014). Indeed, studies of shared platform coopetition can carefully explore the intricate interplay between these two modes and theorize the different patterns of their coevolution. Of particular interest is to identify what are the antecedents, mechanisms, and consequences that drive their interplay and how they shape platform processes (Gawer 2014).

Shared platform initiatives that face technology architecture shifts when developing technology standards are excellent milieus for advancing the current understanding of the evolution of coopetitive dynamics and their respective implications for platform governance strategies. The variety of the technologies and stakeholders involved in open platform initiatives constitutes a complex and rapidly changing ecosystem (Wareham et al. 2014). Such ecosystem needs to encompass heterogeneous groups of technology vendors and user organizations without fragmenting, and platform initiatives that evolve into rival, homogeneous groups are less likely to develop a new technology standard that wins industry acceptance (Markus et al. 2006).

Despite a long history of standardization research on development barriers, switching costs, diffusion patterns, and network effects (Backhouse et al. 2006; Chen and Forman 2006; Weitzel et al. 2006), many shared platform initiatives fail. Lack of adequate governance that leads to coopetitive relationships becoming competition-dominant is to blame for such failures (Garud et al. 2002; Saadatmand and Lindgren 2016). Recent research has therefore called for studies of coopetition evolution (Bouncken et al. 2015) and platform governance (Eisenmann 2008; Eisenmann 2011; Tiwana 2015; Wareham et al. 2014). For example, Wareham et al (2014) point out that a better understanding of changing maturity levels of governance strategies would help explicate the ways in which shared platform coopetition evolves. Here Gawer's (2014) integrative framework offers a theoretical foundation that allows me to explore how decisions about platform scope and degree of platform openness interact and why they affect platform innovation and competition. Indeed, such exploration may reveal what are the drivers and consequences of changes in the degree of openness of platforms as they evolve over time.

## Research Design

My research is based on a twelve-year (2002-2013) shared platform initiative within the Swedish road haulage industry that led to a new technology standard for integration of stationary enterprise systems with emerging

embedded and mobile technologies. From the outset, the project was designed as action research based on established traditions within the IS discipline (Baskerville and Myers 2004; Lindgren et al. 2004; Mathiassen 2002; McKay and Marshall 2001; Susman and Evered 1978). While the idea to rely on Gawer's (2014) integrative framework for conceptualizing shared platform coopetition emerged after the completion of the action research effort, I apply it as an overarching interpretive lens to retrospectively make sense of how the problem-solving activities led to a new technology standard.

In the next section, I introduce the problem setting in which the project unfolded together with a description of how the data collection was organized. Subsequently, I have described the method used to analyze the data to support theory development. Thereafter, I offer an historical background of the twelve-year shared platform initiative within the Swedish road haulage industry. This historical background serves to illustrate Swedish road haulage industry before shared platform initiative in general, and the importance of initiating a shared platform in particular. Gawer's (2014) integrative framework is then applied to provide a detailed analysis of not only the ways in which technology architecture shifts shape coopetitive dynamics in such settings, but also how governance to reduce resource heterogeneity may culminate in intensified competition between ecosystem actors. In particular, I identify critical events and associate them with coopetitive dynamics in shared platform project over the considered time period. This analysis creates the foundation for developing theoretical contributions to the platform literature by discussing the nature of the coopetitive dynamics that characterize shared platform initiatives where emerging technology architectural shifts challenge their governance strategies. In addition to these theoretical insights, my dissertation offers implications for platform leaders who seek to nurture innovation in their ecosystems.

## Problem Setting

Road haulage firms typically consist of mobile field operations and stationary headquarters. Digital infrastructures for such organizations therefore contain embedded, mobile as well as stationary computing resources (Andersson and Lindgren 2005; Lindgren et al. 2008). The corresponding technological realms are commercial telematics, nomadic devices, and administrative enterprise planning. Embedded systems serve different purposes for various users. Services that utilize vehicle data to display feedback metrics on the performance of the vehicle for the driver may, for

example, raise awareness of fuel consumption. Management responsible for fleet performance can use the recorded digital traces of fieldwork to minimize the cost of a transport assignment in terms of time and fuel expenditure. Stationary systems help dispatchers remotely coordinate assignments via displaying the positions of each truck and by communicating associated information to drivers via integrated mobile systems. Embedded GPS-based positioning systems enable dispatching and in-vehicle navigation services. Table 1 presents a summary of classes of IT support in road haulage firms.

| Class | Infrastructure | Functionality |
|---|---|---|
| *Embedded systems:* aimed at improving the efficiency of vehicles/drivers | • Active ignition sensing software<br>• Barcode scanners<br>• CAN-bus<br>• GPS receiver<br>• RFID technology<br>• Trip recording software | • Breaking and shifting behavior analysis<br>• Driver working time analysis<br>• Driving and stopping times tracking<br>• Fuel consumption and trip distance monitoring<br>• Information about mobile workers' positions<br>• Maintenance planning<br>• Navigation support |
| *Mobile systems:* aimed at improving the efficiency of mobile workers | • Nomadic devices in cockpit (coupled to vehicle electronics)<br>• Vehicle-mounted communication terminals (share platform with vehicle-centric applications) | • Verbal communication between stationary personnel and mobile workers<br>• Remote access to stationary planning systems<br>• Text messaging |
| *Stationary systems:* aimed at improving the efficiency of dispatchers/managers | • Geographical information systems<br>• Fleet management applications (integrated with ERP software) | • Event-triggered alerts and geo-fencing<br>• Geo-positioning<br>• Order management<br>• Route optimization<br>• Cargo and vehicle monitoring and tracking |

**Table 1 Classes of IT support in road haulage firms**

Historically, the lack of standardized interfaces for integration of embedded, mobile, and stationary IT systems has undermined Swedish road haulage firms' attempts to innovate digital infrastructures (Andersson and Lindgren 2005; Lindgren et al. 2008). While lock-in effects of proprietary interfaces created gaps between social and

technical elements within firms, they also hindered inter-organizational partnership arrangements. As a result, it was difficult to reduce $CO_2$ emissions by improving fleet utilization and implementing flexible logistics operations.

To break with the dominating proprietary agenda, the rationale behind the reported shared platform initiative was that assemblages of embedded, mobile, and stationary technologies (paired with behavioral improvement) have the potential to curb some of the environmental impacts of road transports (Andersson et al. 2008) and facilitates digitalization of road haulers' workflows. Consisting of highly heterogeneous social and technical components with complex dependencies, however, such assemblages must be managed through well-defined standardized interfaces between constituent layers (Tilson et al. 2010). Accordingly, in "Mobile-Stationary Interface" (hereafter MSI) project the developed interface can be classified as a vertical technology standard to allow transport processes within and across individual road haulage firms to achieve desired outcomes (Table 2). These standards prescribe data structures and definitions, document formats, and business processes for particular industries (Malhotra et al. 2007; Wigand et al. 2005ab). Bala and Venkatesh (2007, p. 341) note that such standards "not only specify and define the structure and format of business messages through a common language but also orchestrate the message exchange choreography, i.e., sequence of steps required to execute an atomic business process among trading partners".

**Vision**

A modern truck contains technology to sense its state and make vehicle-related data available via the built-in CAN bus. Telematics software also includes a GPS chip so that a position can be attached to each data point. The vision of the MSI project was remote real-time access to the connected truck and integrating this data in stationary systems. Such connectivity caters for data about driver times, engine temperature, fuel consumption, gearshift patterns, geographical location, idling time, maintenance timing, oil pressure, speed metrics etc. These time-stamped data leverage monitoring processes necessary for cleaner transports by enabling efficient planning. For example, formalized assignment processing within the confines of an integrated computational solution, combined with automated instant retrieval of vehicle performance data, facilitated by wireless communication ensure constantly updated sources of timely information. Each truck in a fleet is seen as a sensitized object capable of collecting and reporting high-level granularity data, making them essential enablers of eco-effective fleet management operations. However, they depend on standards-enabled information infrastructures that integrate embedded and mobile technologies with back-end enterprise IT systems. Such infrastructures rely on a "plug-and-play capability" in that they allow constituent technologies to recognize and establish working configurations with other components. This capability has the potential to tie together various social and technical elements within and across organizations in novel ways.

**History**

The pioneering efforts with the MSI project were initiated by Viktoria Institute back in 2002, and some 2 years later the involved actors decided to form a consortium to develop and promote an industry standard. To pursue unison at the industry level has been critical for two reasons: 1) Enable different technology vendors to learn one interface and minimizing friction between heterogeneous systems; and 2) Create information consistency across road haulage firms and leveraging inter-organizational process linkages. A team led by an action researcher and composed of technical staff at the participating firms executed the standard design process. Based on a thorough review of the proprietary interfaces of the involved firms, the team developed a standard that was revised over multiple iterations. The firms evaluated each release of the standard in light of their own proprietary interfaces and ongoing integration projects. User firms discussed suggestions for improvements with vendor representatives in project and work meetings, and some were implemented in a new prototype that was again subject to discussions. The standard was evaluated through three test cases in 2006. One year later, in 2007, the MSI Group was formally established as a commercial consortium. Two authentic integration projects were carried out in 2009, and 12 road haulage firms have implemented the MSI standard.

*Table 2 MSI desired outcome*

The potential reduction in fuel consumption was the main environmental benefit directly associated with the MSI standard. It was recognized that fuel consumption and associated $CO_2$ emissions can be reduced in three distinct ways (Andersson and Lindgren 2005): 1) enhanced driving behavior (e.g., minimized idling time); 2) optimized route guidance; and 3) improved cargo planning (e.g., fully loaded trucks). These measures could enable road haulage firms manage their truck fleets to become more environmentally friendly. By the same token, these actions promised to generate new digital options and associated business opportunities for technology vendors as the innovation orientation of the action research sought to anticipate tomorrow's needs to help create a technologically superior industry standard (Andersson et al. 2008). In what follows, I describe briefly how the research effort was organized to help the industry actors form a shared platform initiative capable of anticipating and materializing these future sources of eco-effective transport practices.

## Research Approach

The project[1] was a collaborative effort between the Viktoria Institute and an extensive transport industry network. The latter consisted of fourteen technology vendors (Addmobile, Barkfors, Consafe Logistics, Cybercom Group, DPS, Halda, Hogia, IBS, NL Partner/Locus Scandinavia, MobiOne, Mobistics, Netlink, Transics, Transware, and Vehco), two truck manufacturers (Scania and Volvo Trucks), a number of road haulage firms, and a consulting organization owned by fifteen Swedish transport organizations (TRB). The industry actors brought considerable experience with embedded, mobile, and stationary technology to the project. The action researchers brought previous experience with design-oriented action research (Lindgren et al. 2004) and embedded and mobile computing (Henfridsson and Lindgren 2005). Following Avison et al.'s (2001) classification of authority and control, the project structure was staged with shifting power dominance between the participants. Although the researchers initiated the project, the authority was assigned to a team consisting of practitioners and researchers once the Client-Researcher Agreement (Davison et al. 2004) was signed. The project was coordinated by different researchers, but as the project progressed control was increasingly dominated by industry interests. While the project spanned over almost twelve years (2002-2013), I have included its aftermath by extending the study period to the summer of 2016.

The data collected in this project involved numerous data sources including semi-structured interviews, board, project, and work meetings, workshops, e-mails as well as strategy and technical documents. In addition to these main sources, I had access to a large quantity of industry presentations, project applications, press releases, popular press articles, module and standard specifications, and use case and test case descriptions. Table 3 provides an overview of all data sources included in the study. The three most important sources of data are project meetings, work meetings, and interviews. In total, 30 project meetings were held over the twelve-year effort. Typically chaired by the researchers, the meetings helped coordinate the project and mobilize support for the research agenda. The recorded and transcribed material from these meetings provided detailed description on the group dynamic. 75 work meetings were held with member organizations. These meetings primarily concerned the technical

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[1] VINNOVA, Swedish ICT (research institute group), MSI Group, and the participating organizations funded the project. VINNOVA is the Swedish Agency for Innovation Systems, which integrates research and development in technology, transport, and working life. VINNOVA's mission is to promote sustainable growth by financing R&D and developing effective innovation systems. For more information, go to http://www.vinnova.se/.

development of standard prototypes and modules. Most of the meetings were recorded and transcribed for later data analysis. Finally, 136 formal interviews were performed, recorded, and transcribed. Respondents included technology vendors, developers, drivers, dispatchers, and haulage firm managers. The interviews lasted 80 minutes in average and covered different themes relevant to IT development and use in the road haulage setting.

| Data sources | Amount |
|---|---|
| Interviews | 136 (80 min) |
| Project meetings | 30 (Average: 240 min) |
| Work meetings | 75 (Average: 120 min) |
| Workshops | 18 (Average: 300 min) |
| Board meetings | 18 (Average: 75 min) |
| Emails (dealt exclusively with substantive issues) | 267 |
| Presentations (Word documents, power points) | 83 |
| Project applications | 9 |
| Decision letters | 5 |
| Strategy documents (IT vendors, MSI group) | 32 |
| Technical documents (IT vendors, MSI group) | 21 |
| System demonstrations | 18 |
| Standard applications | 22 |
| Environmental reports | 14 |
| Module specifications | 12 |
| Press releases | 12 |
| Popular press articles | 11 |

**Table 3 Overview of data sources**

The data was mostly gathered by other researchers who were involved in the project during its different phases. During the ultimate phase of the MSI, however, I took active participation in data collection as a research assistant. I was present in all workshops, meetings and interviews which gave me an opportunity to observe the network dynamics, and to contact actors to gain better understanding of their views, motives, and tensions. All these empirical insights were documented in observation notes. Further, I helped with development of technology architecture that gave me useful insights into architectural design of the platform. After completion of the MSI, I did complementary interviews with the main actors to carefully discuss events described in contradictory documents and the aftermath of the project.

I have analyzed the large bulk of field data by drawing on Gawer's (2014) integrative framework. Given my ambition to carefully scrutinize the evolution of shared platform coopetition, the first step of the analysis involved extracting a timeline with the main activities and events (Figure 1).
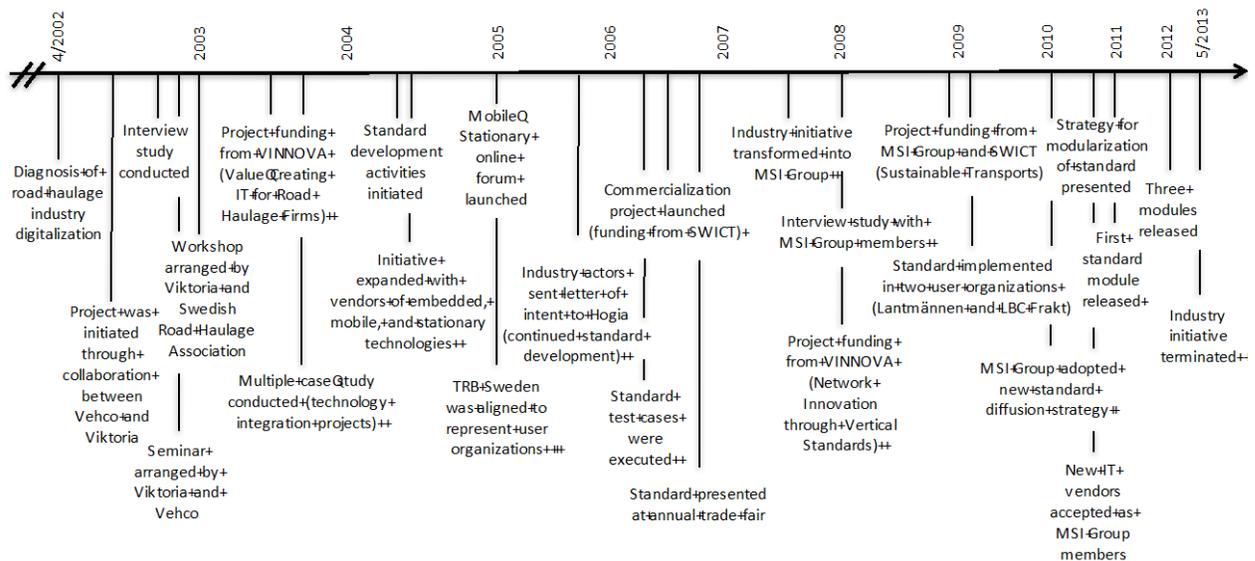


Figure 1 MSI timeline with key activities and events

This analysis led to the identification of three major technology architecture shifts, which serve as a baseline for the key episodes that make up the narrative of my case interpretation. Each episode consists of a technology architecture shift and the ramifications of the transition in terms of coopetitive dynamics as well as related governance strategies.

Based on my analysis of these episodes, I seek to contribute to the platform literature by discussing the nature of the coopetitive dynamics that characterize shared platform initiatives where emerging technology architectural shifts challenge their governance strategies.

## Method

Lack of contextual understanding makes re-analyzing secondary qualitative data challenging (Corti 2007). This challenge, however, is viewed as a blessing in disguise because it causes a distance from the data that results in a less biased analysis (Glas 1963; Heaton 2004). The other discussed advantage of re-using other researchers' data is lowering the research cost (Corti 2007; Glas 1963; Heaton 2004). Despite the encouragements, there are very few research in IS that uses data collected by other researchers. This scarcity can be traced to problems surrounding this method of data gathering and analysis. Methodologically, analyzing such data brings more complexity to the researcher's desk. Ethically, use of such data can be challenging since human objects gave consent to use the data for a research other than the project at hand and finally credibility of such data should be carefully scrutinized. Besides methodological and ethical problems, however, lack of norms and standards in making data available from one research to the other should not be neglected (Corti 2007). Indeed, qualitative researchers can benefit from clear standards and frameworks to regulate re-use of data.

The data for this study is not only secondary but also of historical nature dating back to more than a decade ago. This makes this data eligible for both secondary and historical analysis. These two analysis methods have many overlaps. Both have special focus on how to use and interpret data that is not gathered by the researcher. Historical analysis, however, pays closer attention to handling a larger amount of secondary data; how to organize, how to validate and when to stop collecting more data are center stage. Therefore, in order to be able to analyze and categorize the huge amount of data seen in table 1 I used Historical Analysis (hereafter HA) framework (Mason et al. 1997ab). Mason et al (1997ab) have presented this framework for IS researcher inspired by historical analysis frameworks done by historians and social scientists. This framework offers a comprehensive guideline through all steps of analysis from understanding the data to writing the narrative via the appropriate lens. I followed what Porra

et al. (2014) calls Interpretivist historical analysis relying on Walsham's (1995) work on interpreting qualitative material.

In what follows I give a closer look at HA by presenting its importance and background in IS. I then go through each step HA offers to analyze historical data. For each step, I explain how the step unfolds and clarify how I have conducted that step in my project. I conclude method section with what was learned through applying Mason et al's (1997ab) framework and what challenges I faced.

## Historical Analysis

History is one of the cornerstones of any field. IS is not an exception therefore the study of history in the field has been emphasized in the discipline through various callings for further research to enrich the history of the field. Joseph Schumpeter, the economist and historian, suggests any field of scientific research needs to produce four kinds of knowledge to be qualified as a "discipline" : (1) empirical data, observations and facts, (2) theories and paradigms, (3) ethics, and (4) history (Mason et al. 1997a, p. 258). Study of history is necessary to make meaning of the other three knowledge forms over time. However, IS knowledge production is heavier on the first two (Orlikowski and Baroudi 1991; Porra et al 2014).

Scrutinizing the interplay of social and economic factors of using IT over time is an important field of research in IS. However, longitudinal studies that look into such factors through analyzing changes over an extended period of time are needed. This scarcity of research on continuity is even more noticeable when it comes to research on aligning interests of a group of heterogeneous actors with different perceptions of reality.

IS is a somewhat young discipline therefore the study of history is not as regulated and rich as it is in sociology, history or not even management. Disciplines with stronger historical works have their own approach and frameworks to conduct the study of history in the field, all inspired by historians' works. In IS the only established framework is the framework introduced by Mason et al (1997ab) consisting of seven steps (Mason et al. 1997ab). Through their framework, Mason et al (1997ab) hold IS researcher's hand through the analysis process; beginning

from narrowing the researcher's focus until writing the transcript based on the mountain of historical/archival data. Mason and his colleagues apply their framework on historical account on Bank of America (Mason et al. 1997ab) that gives better insights on how to use the framework.

Not so many IS researchers have followed Mason and his colleagues' footsteps. Porra et al (2005) are the only IS researchers that have done an historical work that is published by top journals in IS after Mason et al. (1997 ab). They used Mason et al's (1997ab) framework on an historical account of Texaco corporate oil company's Information Technology functions (Porra et al. 2005). Later in 2014, Porra and her colleagues provided a rich four layer framework including paradigm, method, approach and techniques in HA (Porra et al. 2014). The IS community's interest is growing in understanding the historical context of IS phenomena. Studying the evolution of IS phenomenon not only helps us understand the events happened in the past that affected the IS phenomenon but it affects the future by learning failure and success parameters of previous endeavors (Mason et al. 1997a; Porra et al. 2014; McKenney et al. 1997). Deeper understanding of the IS changes is argued to help IS scholars to have a sound knowledge of the field and the field's origin and identity (Bryant et al. 2013).

Bannister (2002), however, believes that historical works in IS are not radically different from other popular research types produced in the field. In contrast, Bryant et al (2013) and Oinas-Kukkonen and Oinas-Kukkonen (2013) believe understanding historical methods and techniques is a valuable asset for any IS researcher to be able to interpret previous research. Indeed, observing continuity with the right tools is of great importance in studies that evolves around scrutinizing use of technology.

Historical analysis studies (e.g., Porra et al. 2014) and longitudinal studies (e.g., Gregory et al. 2013; Sun 2013; Ranerup 2012; Bhattacherjee and Premkumar 2004; Venkatesh and Brown 2001; Webster 1998) can be perceived as very similar since they both look into events over time. But a fundamental difference is that in HA researchers let the events and data guide the study while in longitudinal studies theories set the guidelines for research design and data collection (Porra et al. 2014; Mason 2002).

Mason et al (1997a) were inspired by HA in other disciplines including history, sociology, and management disciplines. They coined their framework as "an historical analysis" pointing to the fact that for each step they have elaborated the ways they can be done based on interpretive guidelines. However, each step can look differently and the researcher can choose other qualitative approaches common in IS (i.e., critical or positivist (Myers 1997)). On the contrary, Porra et al (2014) call their take on HA "The historical analysis" because they go through different paradigms (e.g., functionalism), approaches (e.g., pragmatic) and methods (e.g., case study) that are familiar to IS researchers.

## Historical Analysis Steps

Different disciplines approach the process of forming a narrative out of historical or archival data with different assumptions and interpretations. Consequently, historical analysis is presented in different steps across courses of studies: e.g., Scientific HA has three steps (Grigg 1991), marketing HA has five steps (Golder 2000), consumer HA has three steps (Smith and Lux 1993), etc.

In IS the qualitative method of historical research is presented in seven steps: (1) begin with focusing questions, (2) specify the domain, (3) gather evidence, (4) critique the evidence, (5) determine patterns, (6) tell the story, and (7) write the transcript (Mason et al.1997a). Below each step is introduced thoroughly and explained in relation to this study's empirical context.

### *Step1: Focusing questions*

The researcher should initiate the analysis by having some general questions in mind before approaching the data (Mason et al. 1997a). The general assumption at this phase of the history writing is that "material must precede the thesis" (Tuchman 1981, p. 9). This step is for historians to shape open-ended questions (Oinas-Kukkonen and Oinas-Kukkonen 2013) before going forward. At this stage, the questions can be vague and serve as a simple guidance. This step has been known to take a long time to accomplish (Mason et al. 1997a; Mason et al. 1997b; Porra et al. 2005; Porra et al. 2014) mainly because the historians need to approach the "never-ending" evidence to some extent to be able to reach the questions.

For this study, I approached the material to simply fathom the network dynamics and how the Swedish road haulage industry had changed over the course of the MSI project. My involvement in the last phase of the MSI project was helpful in this step. By using Leximancer, I developed an initial theme analysis to understand dominating themes in the data. My initial understanding of the material is described in an extended abstract titled "Technology Standardization for Transport Efficiency: On the Greening of Frames". I wrote this extended abstract together with Rikard Lindgren which was accepted to OASIS pre-ICIS 2014 workshop.

As the result of the process explained above my overarching question became: "What are the dynamics of shared platform coopetition and their respective implications for governance strategies?". Coopetition in short refers to cooperation between competitors which I use in this project as my lens. More information on coopetition will follow under the "Design Pattern" step which is the step there the researcher should identify the lens she uses to categorize and analyze the data and formulate it in a story from an angle the lens helps to shape.

### *Step2: Specify the domain*

The questions produced in step 1 determine the domain for inquiry and dictates several methodological presupposition (Mason et al. 1997a, p312). The domain in this study is the shared platform. I am analyzing the network of actors that are part of designing the platform, the architecture of the platform and the connections between these two. To be able to design the core and standardized interface of the platform, a varied heterogeneous group of actors were invited to this initiative resulting in dynamic relationships in the group.

Historically, Swedish road haulage firms did their work by help of pen and paper; their workflow spanned from getting an order, dedicating the task to a driver, determining the most appropriate route to delivering the goods. By the beginning of the millennium, software vendors and truck manufacturers start attempts on digitalizing the process. The result of such projects, although, helped digitalizing some parts of the workflow but it was far from perfect. Firstly, there existed various software for different parts of the workflow (e.g., order handling to handle orders or route optimization to find the viable route) but these software were not integrated with each other, so haulers had to do the data converting from and to different software manually which given the low IT competence these companies had was not a hurdle to ignore. Secondly, in addition to the problem mentioned earlier, multiple software

options were available for each part (e.g., there were three main software vendors offering order handling software package at 2003). Consequently, haulers would end up with different customers demanding different software for performing the same task. The ultimate problem was that truck manufacturers produced digital platforms that worked only for their truck brand which made transport management more complicated for haulers. The MSI project provided the industry with a trading zone there these different actor types of the ecosystem would gather and help to develop a standard. This data exchange standard would make it possible for different platforms to communicate with each other and integrate. Finally, the result of the effort would provide haulers with a comprehensive system for the first time in the history of the industry.

The preamble above makes it clear that to study the cooperation between competitors (i.e. coopetition), having the network as the main domain was necessary. As the secondary domain, I look into the technology architecture the network designed.

### *Step3: Gather evidence*

Timeline is a typical technique historians use to organize evidence by dividing the storyline into relevant time periods and name them (Marwick 2001).  In interpretivist IS histories, evidence gathering processes ascribe to a social relativist perspective, which suggests that evidence is considered to be an interpretation of the events by the authors of the documents (Porra et al. 2014). Among all data sources, Interpretivism considers interviews to be the most important source of understanding the actors' interpretations of actions and events that have taken place (Walsham 1995).

In the MSI project, the data was mostly categorized by the type of the documents e.g., fund applications, project meetings, technical meetings, interviews, etc. However,  to be able to extract the timeline of important events, I needed to categorize the data into years. The challenge I faced in this step was that many of the interviews, observations and even meeting notes did not have enough introductory information including the date. Therefore, I wrote a  C#.Net application which went through all the files and categorized them by the creation date and language of the files. I took the language into consideration to separate Swedish and English material for each year in case I needed to use computer aided narrative analysis later in the process.

### *Step4: Critique the evidence*

The gathered evidence needs to be critiqued and evaluated in this step. "Some will be false, some contradictory, much irrelevant, and most of it will be incomplete. Given questionable or untested evidence, several analytical processes can be called into play" (Mason et al. 1997a). Historians examine different sources and make conscious decisions on which material to use (Howell and Prevenier 2001). These decisions are heavily influenced by the reliability of the material. If a combination of the various sources, e.g., oral history, and archival material reflect the same story the reliability increases (Oinas-Kukkonen and Oinas-Kukkonen 2013). According to McKenney et al (1997), contradictory evidence includes conflicting dates of events; changing times for hardware upgrades; differing volume figures, non-matching recollections of members in attendance at meetings; and different cost figures. It is important that the facts make the final judgements of credibility, not the theory.

After categorizing the data into years, I consulted with the MSI project manager to examine credibility of the sources. During this process a problem with interview transcription file dates surfaced. Some interviews had been transcribed a year after the actual date of interviews; therefore, their file creation dates did not match the year of occurrence. I changed the timeline and file categorizations accordingly.

Furthermore, I went through each document specifying who had produced the document (e.g., who had conducted the interview), which date was it collected and for which purpose. Next, I extracted events that did not agree with each other going through different documents and taking the events that most documents agree into account. In this juncture, repititive meetings with the MSI project manager were very helpful because he had been the eyewitness of all the episodes.

### *Step5: Determine Patterns*

Collected evidence in its unprocessed state is of little value but gains its meaning when historians interpret it for their narratives (Munslow 1997). A history is a written explanation of the perceived relationship between different fragments of evidence that the historian puts together to organize the story (Mason et al. 1997b; Porra et al. 2014).

Munslow (1997, p. 8) presents this stage as "The inference of meaning emerges as we organize, configure and emplot data. It does not, I would argue, just turn up or suggest itself as the only or most likely conclusion to draw".

I found coopetition dynamics interesting and important in the MSI project. An initial analysis of coopetition in the MSI project was illustrated in a paper titled "The Tension between Stabilized Cooperation and Intensified Competition: Greening of Technological Frames in Practice" that I wrote together with Rikard Lindgren which was accepted and presented in Journal of AIS (JAIS) Theory Development Pre-ICIS 2015 Workshop. I later presented the full-fledged analysis in a paper that I wrote together with Rikard Lindgren under the same title. The paper was accepted and presented in Hawaii International Conference on System Sciences (HICSS) 2016.

While conducting the analysis for the HICSS study, I realized cooperation dynamics between competitors had been heavily affected by the changes in technological architectures through the years that, consequently, impacted the standard. As a result, I divided the project into three episodes reflecting the three main architectural changes. In the first episode, the prominent technology that actors initially agreed on to base the shared platform architecture on is the Open Services Gateway Initiative (hereafter OSGi). OSGi was the latest technology at the time which had attracted attention among logistic actors as a technology that made integration processes possible. The second episode is the Web Services episode; this technology became the core technology architecture for the shared platform together with the XML data type, and the last episode is about modularization, but the determining technology affecting the network and events was Apps. Apps was the latest technology in the industry at that time that MSI diffusion got heavily affected by it. Afterwards, I go through each episode and focus on relationships between actors and thrive to analyze, investigate and explain them through coopetition as the lens and the effects technology architecture had on coopetitive dynamics.

As stated earlier, Gawer conceptualizes a platform as an organization or a meta-organization consisting of three aspects of architecture, network and value creation (Gawer 2014). In ach episode, I used her framework as a lens to present and analyze the MSI shared platform through the triangle Gawer (2014) represents. I found coopetition a helpful lens for looking into network dynamics. On the other hand, given how nascent coopetition is, the MSI project is an excellent opportunity for contribution as well.

I presented the analysis of coopetitive dynamics in face of technological architecture changes discussed above in connection to Gawer's (2014) framework in three dissertation proposals that were accepted for European Conference on Informaiton Systems (ECIS) 2016 Doctoral Consortium, Organizational Communication and Information Systems/ a division of Academy of Management (OCIS) 2016 Doctoral Consortium, and International Conference on Information Systems (ICIS) 2016 Doctoral Consortium.[2]

### *Step6: Tell the story*

An interesting narrative supported by evidence should be provided in this stage. Histories include reverse history: creating narratives about the past by backtracking from the present circumstances (Bryant et al. 2013; Porra et al. 2014). This narrative should be presented in an interesting way without jeopardizing the integrity and consistency of the evidence (Mason et al. 1997b).

The historian should explain the changes she is studying by putting the evidence into narrative form resulting into "thick descriptions" of set of events. IS interpretivists borrow the "thick description" concept from anthropology to describe organizational changes into details to be able to make complex concepts and dynamics understandable (Walsham 1995). Historical narratives are well structured and can have three causal levels (Smith and Lux 1993). At the first level of the story are deep structural causes, which present the continuity factor. In the MSI project these types of causes included the start of changing mindset between vendors through integration processes, rise of tech industry, the enormous success of a start-up merely because of focusing on haulers' needs instead of focusing on truck manufacturers' needs, the invention of Web Services and XML, the invention of OSGi, and the invention of Apps. The second level of contextual causes focuses specifically on the temporal relationship to the event being investigated (Bloch 1953). In the MSI project, these types of causes included IT strategic decisions, annual standard meetings, and activity reports. The third level or triggering causes are unique to each episode (Porra et al. 2014). In the MSI, year 2003 is famous for FMS standard (Fleet Management System standard) and year 2010 for letting a third party being the most prominent actor of the standard.

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[2] I presented my work at ECIS 2016 DC in June 2016. I was unable to present my work at OCIS 2016 DC because of delay in my U.S. visa processing, and I will participate in ICIS 2016 DC in December 2016.

While composing the story, I realized that information regarding some events was not clear or missing. Researchers that were part of the project, they were not sure about the answers. Therefore, I conducted three complementary interviews with some of the key actors that had been part of the MSI initiative through all these twelve years. I particularly searched for deeper understanding of the events and motives that were vague and not documented earlier. In selection process of interviewees, I tried to pick a balanced group of actors. I chose one of the interviewees from the customer side of the platform, one from the software provider and one from truck manufacturer category. These interviews were semi-constructed interviews; I posed questions about the events I needed more information of, the after math of the MSI, and how the MSI has helped the actors in their projects today. Also, I let them to talk about their views and ideas of the project, other events they wanted to focus on, or to express their views on what they perceived as successes or failures in the MSI and finally on how such shared platform initiative would have happened today. In general, I tried to keep a "balance between excessive passivity and over direction" (Walsham 1995, p. 78) while interviewing. In all complementary interviews, I invited the MSI project manager to be present to assist interviewees' in remembering the events and even to do a validation in place. Complementary interviews were transcribed, shortly after, and further corrected by me. Later the interviews were sent to the MSI project manager for an ultimate validation to get feedback if there are conflicting views on the timeline or events presented by the interviewee.

I approached my project in a double hermeneutics form inspired by Porra et al.'s work (2005); that is, I treated the meanings actors assigned to their past with the understanding that these meanings were already interpretations of the actual happenings. While writing the story, I also interpreted the evidence based on my understanding and readings. However, where applicable, I used primary sources to strengthen the reliability of interviews, meeting notes or emails (e.g., funding application).

### *Step7: Write the transcript*

"A transcript is literally something reduced to writing but for an historian it has a broader meaning as well: it is the placing of the historian's written words in the schema of those which were written before." (Mason et al. 1997b, p. 317). After putting together the story of each episode, I put the pieces together and looked into the relationship

between each episode analyzing the patterns. I put a historical context of the project (presented as Historical Background) to describe the industry before the MSI started. This background was provided to help reader to understand the complexity of the problem the MSI thrived to solve. Finally, I went through each episode and tried to give a coherent picture of the project. Furthermore, I added quotes from the data to support the story where needed.

While writing and interpreting the material, I tried to take the outside observer role other than involved researcher. However, I agree with Walsham (1995) that neither of these roles (i.e., observer or involved) result in pure objective results since researcher's subjectivity affects different stages of the study. I have not been totally unbiased through the process. First, I have followed the data through angles that I have been interested to explore. Second, I have had my interpretations of the project both because of my involvement and because of my perceptions of events. Moreover, my education and work experiences motivated me to scrutinize technological aspects, which meant that technological shifts became a significant aspect of my research.

## Limitations and Challenges

Mason et al's (1997b) historical analysis framework is proposed in a sequential form. However, as Porra et al (2014) have briefly pointed out, it is more iterative and complicated than presented. The knowledge gained in each step caused me to go back to redo previous steps or revisit the assumptions made before.This problem stemmed from the lack of contextual knowledge I suffered from in dealing with secondary data. Therefore, I believe a researcher should not completely distance herself from actors involved in collecting the primary data for the sake of objectivity. Such contacts helped me to understand the material properly. The challenge, however, for me was that many of the actors were not reachable or uninterested to help. Indeed, remembering the events as they unfolded many years ago was not easy for those people I actually talked to.

Another challenge I faced was that the documentation of research material did not follow a proper guideline and different researchers had followed different methods to archive. The richer the data collected by researchers, the easier it was for me to re-analyze the qualitative data. More illustrative data archiving methods in collecting qualitative data e.g., illustrative interview methods presented by Schultze and Avital (2010) had been of

huge help. Because in some cases interviewees talked about a diagram or system demonstration document they were showig that was not attached to either the voice file or the transcript.

The problem of "data fit" discussed in secondary analysis (Heaton 2004); that is when the data is not enough or appropriate for the theory lens remained. Although, HA specifically focuses on guiding the process with data. I initially chose open innovation as the theory lens, but after 6 months realized that it did not match my data. This problem was heavily connected to the lack of contextual understanding that can missguide the researcher to the "wrong" theory lens. Therefore, more illustrative data, availability of different sources for the same events, and more available actors and researchers to contact could have helped to prevent me from wasting a long time on the "data fit" problem.

## Historical Background

In the late 1990s, the Swedish road haulage industry consisted mainly of small local firms with deep-rooted traditions (Andersson and Lindgren 2005). Statistics from the Swedish Road Haulage Association (hereafter SRHA) suggest that up to 90 percent of its members operated five or fewer vehicles. Recently, the European Union's open market policy allowed foreign road haulers to increase their market share in Sweden. As a result, increased competition from Danish, German, and Polish firms lowered profit margins and large global firms like Danzas and Schenker strengthened their market positions.

Stationary planning systems and mobile phones had for long been used to manage road transport. However, Swedish road haulage firms believed embedded and mobile technologies could help them coordinate better to cope with the increasing competitive pressures. Fueled by trade press articles and white papers, these companies anticipated increased digitalization would improve mobile resource evaluation, facilitate seamless transport data management, and rationalize dispatcher-driver communication. IT vendors and truck manufacturers also promoted increased digitalization as the next step towards sustainable business processes in haulage firms. Referring to their R&D investments, they predicted most firms would soon rely on these new digital opportunities.

However, there were few available accounts of how assemblages of embedded, mobile, and stationary technologies had led to productivity gains or improved sustainability. In fact, at industry conferences and seminars, the SRHA complained about low penetration of advanced distributed technology among its members. Primary interviews with road haulers also clearly indicated that infrastructure initiatives often faced complex challenges because of the heterogeneous and distributed nature of technologies, organizations, and practices. Apparently, it was hard to transform these socio-technical assemblages, and many firms felt they wasted their money. As a result, there was decreasing willingness to make proactive IT investments amongst small road haulage firms.

Hence, road haulers continued to rely on fragmented infrastructures that prevented productive combination of embedded, mobile, and stationary systems. This 'mobile-stationary divide' was reinforced by several players: 1) truck manufacturers offered embedded solutions dedicated to their brand; 2) vendors offered stationary solutions based on proprietary interfaces and standards; 3) contractors of haulers provided mobile and stationary solutions dedicated to their specific information management needs, and 4) The SRHA propagated a lightweight solution without integration capability to other available IT systems. If small haulers wanted to move from heterogeneous portfolios of IT solutions to integrated digital infrastructures they had to deal with different interfaces and standards and negotiate with many different technology users and providers. That meant they needed to engage in many data interchange activities manually to get the systems to work. Moreover, they needed to understand how strategic decisions and contextual factors would shape the complicated process of aligning interests to achieve a dominant technological design. It all had contributed to the extremely slow IT adoption among haulers.

## Analysis

In this section, I apply Gawer's (2014) integrative framework to provide a detailed analysis of the reported shared platform initiative within the Swedish road haulage industry. The analysis is structured into three major technology architecture shifts that serve as a baseline for the key episodes that make up the narrative of my case interpretation. For each of these episodes, I identify critical events representing coopetitive dynamics in the shared platform. This analysis creates the foundation for explicating the nature of the coopetitive dynamics that characterize shared platform initiatives where emerging technology architecture shifts challenge the platform's governance strategies.

## Episode 1: April 2002 to April 2004 – Open Services Gateway Initiative (OSGi)

In 2002, Vehco (a start-up embedded technology provider) and Viktoria Institute started a research collaboration aimed at digital infrastructure innovation within the Swedish road haulage industry. Vehco was a spin-off from Chalmers University of Technology. They were still seeking funding for R&D activities and their platform strategy seemed feasible and attractive for the industry. A series of meetings about possible venues of joint interest resulted in a partnership with Viktoria to kick-start R&D efforts aiming to digitalize Swedish road transport. It all resulted into the birth of the MSI initiative.

Vehco had done a study on road haulers' needs and had several customers, but the MSI project required to engage a broader group of road haulers. The SRHA was a natural partner and contacts to them provided a deeper understanding of the actual state of IT use within the industry. Road haulers could rarely afford to develop custom built systems, so they typically adopted various off-the-shelf solutions. This was problematic especially for small firms. While these solutions did not cover the broad range of business activities in road haulage, the considerable heterogeneity in technologies and vendors required IT competencies most firms did not have. As a result, the MSI project decided to focus on helping small road haulage firms address their socio-technical struggles.

Initially, the researchers analyzed available IT solutions and core vendor competencies in detail. In fact, stationary technology vendors reached out to include mobile resources (drivers and vehicles) and embedded technology vendors (including truck manufacturers) increasingly embraced traditional stationary domains. Interviews and other data sources from this period of time shows that systems providing IT support to Swedish road haulage industry can be categorized in three sections: embedded, mobile, and stationary. The analysis documents from the varied range of available software at the time shows that the vendors were very much technology-focused and promoted their solutions relative to competitors rather than placing hauler requirements and added value to customers in the center of their business mantra. It was therefore difficult for small haulers to identify gaps and overlaps between different solutions, effectively hampering attempts to combine solutions.

The other prominent problem was lock-in effects; that is, many providers tried to lock their customers to buy only their products with various policies e.g., Truck manufacturers offered only brand-specific solutions. On one hand,

fleets with vehicles from multiple manufacturers were common and integrating different embedded and mobile components with the stationary systems was prohibitively expensive for small firms. A transport and logistics manager at Volvo Trucks explained:

> "Contractors of haulers develop their own tailor-made solutions and try to act as system integrators. They utilize development resources, software, and hardware in a completely ad hoc fashion to accomplish these proprietary solutions."

On the other hand, although vendors were confined within their own technological paradigm and unable to comprehend wider design challenges, they actively promoted their solutions outside their core competence to increase market shares. This led to a persistent problem within the Swedish road haulage industry with failed IT implementation projects as haulers attempted to implement services offered by embedded, mobile, and stationary technology vendors in parallel.

Based on this initial understanding of the socio-technical factors that contributed to the mobile-stationary divide in road haulage firms, the MSI project concluded that IT vendors and haulage firms should meet to discuss industry concerns. This resulted in two seminars organized by the SRHA, Vehco, and the Viktoria Institute during fall 2002 to discuss insights from the researchers' interactions with IT vendors and road haulage firms. The seminars were relatively well attended and appreciated by many, but the communication was largely based on courtesy phrases without stimulating additional knowledge sharing and discussions about collaboration initiatives. In addition, some vendors saw it as an opportunity to promote existing proprietary integration solutions to road haulers and thereby make sure the resulting platform technology was compatible with their installed base. Given the prevailing mindset among vendors, it proved difficult to establish a coopetitive spirit among them, as the sales manager of Locus Scandinavia observed:

> "Vendor representatives have to avoid selling their stuff at these occasions. In our discussion group Volvo did that… I experienced that Hogia, IBS, and myself didn't. From other groups I heard that Transware did, but Scania didn't. As moderators you need to find ways to get rid of such unwanted behavior. When we discuss functionality we should do it without tying specific features to the participating vendors."

In parallel, Vehco worked on open platform prototypes. Ultimately, they sought to inform an agenda for integrating embedded, mobile, and stationary systems in the road transport industry. Drawing on previous studies,

they developed a number of prototypes like "EcoHauler", which was designed to couple on-line readouts on fuel consumption embedded within vehicles with stationary transport data. Despite its somewhat limited design, the prototype rendered much interest when presented at industry conferences and seminars. However, some technology vendors criticized that the design of the service was restricted to a single system vendor (and a particular road haulage firm), but still they expressed willingness to participate in a continued R&D effort.

Researchers tried to, on one hand, help vendors abandon prevailing technology-driven approaches in favor of ones oriented towards meeting hauler needs and expectations. On the other hand, it was important to strengthen the position of small road haulage firms by helping them implement assemblages of embedded, mobile, and stationary technologies in more flexible ways. The initiative therefore had to overcome the legacy of past collaboration attempts and instead accommodate the heterogeneous interests of technology vendors and road haulers alike.

Vehco competed with truck manufacturers' telematics services and wanted to refine its core competence. They were specifically interested in leveraging technology embedded directly into vehicles to support management of small road haulage firms. Vehco had previously done a study on haulers' needs and saw the mobile stationary divide a prominent problem in the industry; therefore, they hoped to generate breakthroughs on how to develop digital infrastructures for small road haulers by integrating embedded technology with mobile and stationary technologies. As a result, Vehco and the Telematics Group(at Viktoria) initiated the MSI shared platform project. The project started with selecting road haulage firms to engage in the shared platform initiative and continued to enroll multiple stakeholders to increase the efficiency and sustainability of road hauling operations through standardized usage of IT.

The initial idea of a technology architecture capable of alleviating communication problems between IT systems (originating from different software vendors) was shaped by the emergence of "OSGi". Whereas the shared platform initiative explored this architectural approach for almost two years, it was originally suggested by Vehco as a way to tie heterogeneous technology components together in a coherent way. The value proposition sought for thus concerned 'compatibility' between technology vendors' different solutions. Despite that several actors recognized OSGi to be an interesting option, Volvo was reluctant to pursue this architectural strategy when engaging in

technology standard development. It had previously collaborated with Gatespace Telematics (a member of the OSGi alliance) and believed OSGi required too close access to its embedded computing resources (i.e., CAN-BUS data). Volvo thus rejected the architectural strategy proposed by other members of the platform initiative. The truck manufacturer instead preferred an architectural approach to technology standard development that could serve as a layer over its own embedded components with minimum information access needed. One of the reasons was security because Volvo perceived a huge risk that OSGi would make it possible for alien technology components to access vehicle specific parameters and possibly even change them. A global telematics manager at Volvo Trucks argued such architecture presented an unwanted security issue:

> "Vehco will never get into that OSGi from an OEM perspective… simply because then they've to become a tier one supplier. It's still Volvo that has the responsibility for completing the service solution and they're just a software company."

Consequently, OSGi did not offer Volvo sufficient means to control its data-openness strategy. Scania, the other truck manufacturer involved in the platform initiative, had limited expertise in OSGi-based development and therefore it relied on Volvo's judgment. In contrast, other providers of software (including Vehco) preferred to go with an architectural solution already known to them to reduce overhead costs. Facing these conflicting interests, the leaders of the platform initiative had to find a more viable architectural solution that would comply with the stakeholders' different needs and preferences. The negotiations about OSGi as a technology integration approach, however, rendered insights that were deemed important to understand how a technology standard could help actors to innovate/cooperate and compete.

The fragmentation of IT support for road haulage firms was a result of institutionalized vendor behavior. Most of them were reluctant to share and rethink their business strategy and that undermined their ability to participate in some form of collective action. In that situation, it was virtually impossible to initiate cooperation between competing vendors that promoted different and in many respects incompatible IT solutions. A critical next step was therefore to expand the platform initiative to start changing the relationships and structures that kept different technology vendors apart. Over a period of six months, in quest for the appropriate architecture structure, the MSI project focused on this challenge through explorations with IT vendors, road haulage firms, and truck

manufacturers. In the summer of 2003, an ecosystem of dominating industry players was in place. Besides Viktoria Institute and Vehco, the founding members were Hogia, NL Partner (was acquired by Locus Scandinavia in late 2005), Scania, and Volvo. All actors believed the arrangement was necessary to establish the inter-organizational processes required for continued industry digitalization. The platform initiative was formalized in a researcher-client agreement to secure commitment and specify roles and responsibilities.

A government agency (VINNOVA) provided funding for the collaboration through the project "Value-Creating IT for Road-Haulage Firms" As a first step, the partners decided to focus on reuse and reconfigure architectural knowledge from already established projects that aimed at integrating embedded, mobile, and stationary technologies into coherent digital infrastructures. The researchers identified the ongoing integration projects, and the other platform members provided access to their cases of heterogeneous technology integration, in effect transcending the long-standing tradition of vendors black boxing their integration procedures. The ongoing integration projects were generally quite modest in terms of technological innovation, and it became apparent that simply reusing and reconfiguring architectural knowledge from different vendors would have a limited effect. In fact, all projects had failed to successfully integrate the involved heterogeneous technologies because of lack of knowledge sharing suggesting that no single vendor had the capacity to develop a comprehensive digital infrastructure of embedded, mobile, and stationary systems. Although some platform members still preferred to work on their own, most of them realized their inability to handle technologies outside their core competency, especially in situations involving technology embedded into vehicles. Hence, the discussion of lessons across integration projects had started to move competing vendors towards closer cooperation.

The researchers' continued analyses of the integration projects revealed how proprietary interfaces both supported and inhibited cooperation amongst vendors and haulage firms. The fact that the IT vendors had created the interfaces suggested they realized a need to develop digital infrastructures that integrated components from diverging sources. Although the vendors would not be able to control such development to strengthen their competitive positions, the interfaces expressed a readiness to engage in efforts to support systems integration. But, the different proprietary interfaces also adversely affected cooperation opportunities. These interfaces were published by stationary vendors to allow their embedded and mobile counterparts to connect to their solutions. So,

embedded and mobile vendors had to comply with the interfaces if they wanted to help haulers establish integrated digital solutions. Reflecting the technological frames and market strategies of the vendors of stationary technology, researchers found that the interfaces offered elaborate support for the stationary systems. In contrast, they provided virtually no support for mobile and, particularly, embedded technology and they were therefore at the heart of the mobile-stationary divide that effectively separated relevant actors. Further explorations suggested that vendors of embedded technology also adopted protective strategies to maintain their competitive positions. Several road haulage firms were not able to evaluate truck performance via their PC-based fleet management systems because inclusion of vehicle sensor data, such as fuel consumption, was hindered by proprietary interfaces. As a result, it was difficult to promote sustainable transport solutions. Insight into these problems with proprietary interfaces further stimulated the members of the platform initiative to create better knowledge sharing opportunities amongst vendors and road haulers.

In addition, the researchers also sought to maintain the commitment from the SRHA and to enroll select individuals with requisite architectural knowledge about the digital infrastructure challenge. The researchers therefore attended a number of meetings with the SRHA IT forum to discuss socio-technical issues related to technology integration. Although the expert groups within SRHA appreciated the insights from the researchers, the interactions did not lead to intensified support from the SRHA. To be able to scrutinize possible architecture candidates for the shared platform, researchers hired former telematics manager at Scania. He was at the time running his own business, ASN IT & Management, offering education about transport process innovation through standardized systems integration to individual road haulage firms and regional road haulage associations. Given his interest and background, he was invited to join the shared platform initiative.

On February 16 2004, a telematics manager from Volvo expressed Volvo's desire to pursue digitalization in a presentation for various actors in the industry. Well aware of Volvo's own problems to build business around embedded technology in its vehicles, he predicted that the already limited IT investments made by road haulers could easily be reduced even more. What was required was a market place for service innovation that would operate based on modularized digital infrastructures enabled by standardized interfaces. He believed shared platform initiative is a good place to build that market place. Virtually all involved parties appreciated Volvo's call for standard development

and it was particularly important that some of the stationary technology vendors agreed a standardized industry interface could help resolve the tensions surrounding integration of embedded, mobile, and stationary systems. At the same time though, they raised concerns about who would be willing to take responsibility for such an effort. Researchers would prefer customers groups to take the bigger role. Therefore, the platform initiative sought support from the SRHA, but it turned the invitation down due to competence and resource shortages. At the same time, SRHA's IT manager owned a business centered on a lightweight proprietary application that was perceived as a competitor platform to the MSI.

A PhD candidate, instead, of the Logistics & Transport research group at Chalmers Technical University who was acting as the IT coordinator of TRB Sweden was invited to the platform group. Enrolling him into the initiative provided access to relevant knowledge about digital infrastructure within the Swedish road haulage industry and it created a major formal link to TRB and many road haulage firms. Thus, the standardization effort started to move forward by making the gap between vendors' goals and haulers' goals slimmer. Vendors knew TRB had successfully represented the road haulers in political negotiations about environmental regulations and transport policies and they therefore believed the extended initiative was a viable arena for development of an industry standard.

The shared platform initiative was now focused on promoting transport innovation through integration of embedded, mobile, and stationary systems and with the specific objective to develop the MSI standard. A key task for the group was to specify a common business terminology for system-to-system communication of transport activities. The researchers' analyses had revealed existing stationary vendor interfaces lacked specifications outside the stationary context such as fuel consumption metrics and working hour data. While this partially explained why these interfaces rarely supported practical integration efforts within road hauler firms, it also meant that the standardization group could not rely on the existing interfaces. As a result, the ASN IT & Management representative took initiative to analyze the Pharos mobile standard, which targeted business processes for larger contractors of haulers rather than small haulage firms. Pharos Mobile was specifically designed for smaller contractor of haulers. Smaller contractor of haulers had same approach as their bigger international equivalents e.g., DHL. Pharos did not target bigger contractor of haulers because those actors had their own in-house solutions. Besides, it was focused on

stationary and order business process and did not cover all business processes. This standard is described as below in the report of the workshop with e-com logistics:

> "Pharos Mobile is a standard developed by e-com Logistics for expedition transports in particular. The problem with this standard is that it is too large, too detailed and yet too small, meaning that it has its focus on package transportations in details."

Although it would add a new level of complexity to rely on the Pharos mobile standard, one important conclusion was that the MSI standard should be based on XML to maximize its diffusion potential. Fortunately, some of the involved vendors had used XML to specify their interfaces and more were in the process of adopting XML. The standardization group therefore decided to develop the new technology integration standard based on XML.

## Episode 2: May 2004 to December 2009 – Web Services (WS)

The insights gained from analyzing ongoing attempts to integrate technology in road haulage firms provided a valuable foundation for future actions. Specifically, it had created an organizing vision that cooperation across competing vendors and road haulers was needed to overcome technological lock-in and counterproductive business strategies. Specifically, it was clear that giving customers (i.e. haulers) a central role helps triggering the coopetitive spirit. At this point, the researchers started to enroll five additional vendors (IBS, MobiOne, Mobistics, Transics, and Transware) into the network. The goal was to expand the ecosystem so that it represented the main part of IT vendors operating in the Swedish road haulage industry at the time.

As stated earlier, given the reactions to OSGi architecture, Viktoria hired a consultant to do research and identify candidate architectural strategies. The modular architecture agreed on initially was reshaped by the emergence of "Web Services". This alternative architectural strategy paved the way for a more sophisticated design of the emerging technology standard (in terms of relationships and interactions between technology vendors). XML was brought forward as a proper solution based on a careful examination of existing solutions and ongoing integration projects. In fact, most of the involved software providers either used it as the exchange data format or were trying to comply with it.

The development of the standard accelerated from early 2005. The researchers realized these efforts would put the cooperative spirit within the platform initiative to test. They therefore decided to host all meetings on

neutral ground. Vendors, especially those with little previous experience of cooperative development efforts, appreciated the Viktoria Institute as the physical meeting place. To spur further interactions among ecosystem members, a forum for developers from different vendors, called "Mobile-Stationary Online Development Forum", was launched. It did not generate very active participation, but the discussions nevertheless led to significant design decisions. During spring 2005 there were meaningful interactions across vendors and haulers with a commitment to overcome the negative impact of proprietary interfaces. The platform initiative had grown strong enough to resist diverging pressures.

The most problematic event emerged from Hogia's proprietary interface. Hogia had a very comprehensive knowledge about XML-based data exchange and its proprietary XML properties because of its integration project experiences; therefore, their XML structure served as a baseline for the technology standard to be developed by the shared platform initiative. Later on, however, Hogia sought to withdraw from the platform initiative. It claimed infringement of its IPR and threatened to sue the other platform members. Hogia was about to broaden its business from Sweden to Europe and the standard development potentially threatened it by giving too much information on its technology architecture to rivals. Hogia simply wanted to continue to integrate systems the way they did and feared a widespread use of XML would disrupt the current integration landscape. The platform initiative faced a bumpy road because it did not have any IPR policy in place. At the same time, the Hogia incident made the platform members aware of the value a new technology standard could offer their businesses, which helped them to push forward.

Still, the stability of the initiative was put to test when Hogia, the dominating stationary technology vendor, threatened to leave the standardization effort. During a meeting in September 2005, Hogia representatives abruptly declared they were investigating whether the current interface prototype posed an infringement of intellectual property rights related to their proprietary interface, and they called for immediate halt of any development. Hogia's behavior was surprising and threatened to derail the entire process. As development was halted, the rest of the platform members analyzed Hogia's claim and how to respond. Researchers worked closely with the TRB representative to author an open letter signed by all remaining members. The letter declared the initiative's intent to go on with the standardization process and invited Hogia to a meeting to reconcile differences. Meanwhile, Hogia put pressure to have the Viktoria Institute withdraw from the standard development. Hogia had a minor share in Swedish

ICT (SWICT), the research group owning Viktoria, and used this to spur debates between senior managers from both sides of the issue. Hogia Logistics expressed their concern in an email in September 2005:

> "When Viktoria asked us to share our experience on standardization, we assumed that Viktoria is a research institute. [Therefore] We voluntarily shared our experiences... As long as I've been able to find in the documents, it was not mentioned that Viktoria would present a standard [project] that would start compete with our and other providers' on the market... It is obvious that the interface project we have done in Hogia Logistics have given Viktoria a big "start help" when Viktoria started its interface [project]... in this project [Viktoria] has developed further what Hogia would never give away to be further developed to an alternative to our own product. "

Eventually, Hogia distributed a letter to the platform initiative declaring it had left the initiative, publicly denouncing legal action, and referring to a company history of a self-developed open interface and a commitment to applied research. The remaining members viewed this reply as arrogant and it galvanized their continued cooperative efforts on designing the architecture. The TRB spokesperson's active role throughout this process had eventually made TRB the prominent representative for haulers and emphasized the centrality of haulers and TRB.

Although, Web Services in conjunction with SOAP and HTTP GET/POST were somewhat new to the industry at the time, they were selected as a feasible architectural solution. In short, it was deemed suitable for communication of different entities via XML without the need of having unnecessary information from sender or receiver entities. The value proposition here concerned 'utility' of the integration standard for user organizations and a first test of it was conducted at two road haulage firms. Platform members continued to improve the architectural solution agreed on, but eventually they realized they needed to redesign the standard fundamentally. The main reason was that user organizations wanted its different parts to be separate from each other to make the overall architecture less complex.

At the time of the Hogia conflict, LBC Frakt Värmland (a member organization of TRB) had decided to invest in a more advanced digital infrastructure that would integrate embedded, mobile, and stationary components from competing vendors. The managing director as well as the IT manager, who both had attended MSI project meetings, saw the emerging standard as aligned with their decisions and they actively pushed to move the standardization process forward. Well aware of the enormous interest among IT vendors to get the contract (the investment was significant), LBC Frakt stated they expected the last vendor to guide the integration effort based on the MSI standard.

The standard was assessed and revised multiple times in light of proprietary interfaces and ongoing integration projects. Three revisions were especially important:

- To support management of working hours, initial designs included inter-system communication between fleet management monitoring services and data from vehicle sensors. However, members found it difficult to conceptualize the required mapping and management of working hours was removed from the standard.

- Incorporating sensor data from embedded systems could give mobile and stationary vendors competitive advantages. Hence, concerns from embedded vendors resulted in a compromise to only include embedded data relevant to transport assignment. While fuel consumption was included, high-resolution data used for other purposes such as vehicle maintenance and engine development were excluded.

- A context schema was developed to support terminology that reflected firm-specific local conditions. Based on this mechanism, the MSI standard could adapt to specific business terms in any given communication. However, this triggered a discussion of who was responsible for defining and managing the schemas. In the end, it was agreed to assign this responsibility to the stationary vendors.

During the summer of 2006, IBS and Vehco tested the MSI standard in one setting (LBC Varberg) and Locus and Vehco tested it in another hauler (LBC Frakt Värmland). Researchers played a major role in designing the test through guidance on how to secure reliable and valid test results. Both assessments suggested the interface required new workflows because of changes in relationships between mobile and stationary vendors. Also, the architecture design process implied a shift away from stationary dominance as all involved actors now had to negotiate the content and structure of critical business information. As a result, the stationary vendors understood that the MSI standard positioned their systems as part of larger infrastructures with other critical components.

During the same period, the platform initiative got funding from SWICT to transform the activity into a commercial standardization consortium. Consequently, researchers and members started to design and implement principles for development, maintenance, and diffusion. In August 2006, the MSI members presented lessons from the test cases at the largest conference event in the Swedish road haulage industry, emphasizing how the interface standard clarified roles and relationships among IT vendors and helped specify the requirements for combining

heterogeneous technologies into a coherent digital infrastructure. This led to considerable attention from trade press, road haulage firms, and IT vendors and made the shared platform initiative well known across the industry.

In late summer 2007, the platform initiative was formally transformed into a commercial standardization consortium financed via member fees. The primary task of the 'MSI Group' was to develop, maintain, and validate the industry standard. The consortium was structured into a board of directors, a strategy team, and a technical committee. The researchers were actively involved in founding the consortium with particular focus on developing a strategy for intellectual property rights to avoid incidents similar to the one with Hogia. The reorganization meant TRB took over leadership in MSI development from the researchers. As the MSI Group stabilized and attracted new technology vendor members, including Barkfors, Consafe Logistics, Cybercomgroup, and Pocketmobile, it came to represent an even broader division of the Swedish road haulage industry. Besides the involved technology providers, there were several representatives of major road haulage firms who acknowledged the benefits MSIG created for them. A comment made by the IT director at Samfrakt and a press release from the managing director of LBC Frakt Värmland are illustrative:

"The MSI standard is an absolute necessity for us cope with future market requirements. It allows spending more time on increasing our market penetration, which will result in improved profitability for ourselves and our customers. It can also help neutralizing (unwanted) competition in the marketplace by lowering switching costs and thereby making technology components easily replaceable."

"We consider this standard as a prerequisite to create synergies between different carriers and to achieve cost-effective solutions for not only them but also their customers. It has obviously been one of the basic requirements of our IT procurement process, which we'll complete fairly soon."

Researchers now turned their attention towards diffusion of the MSI standard. VINNOVA supported the project "Network Innovation through Vertical Standards" to develop specific lessons on how collective action can lead to service innovation enabled by vertical technology standardization. Also, SWICT funded the project "Sustainable Transports" to create new knowledge on how researchers can support digital solutions for environmental sustainability.

To get diffused across the industry, the MSI standard had to be adopted and used by vendors and haulers to improve business processes. However, the vendors were considerably more pleased with the standard because of

its focus on innovative solutions based on new industry practices. As a result, some IT vendors approached the MSI Group in spring of 2009. As an example, vendors focused on route optimization technology found the standard created a whole new world of digital opportunities because it enabled cooperation and information exchange between distinct socio-technical networks. The standard allowed these vendors to see how their solutions could become part of larger digital infrastructures and it gave them a vocabulary and thematic structure they could use in negotiations with potential partners and customers.

The shared infrastructural understanding meant that the cycle time of integration projects could be reduced without compromising quality. This was even true in situations where the MSI standard was not used. Following interactions with vendors that now promoted the standard, Hogia realized integration practice were changing. Facilitated by TRB and the researchers, they therefore returned to the shared platform initiative. This was interpreted by some as an indication of successful standard diffusion on the supply side. During the same period, two haulage firms, Lantmännen and LBC Frakt Värmland, decided to implement digital infrastructures based on the MSI standard. This was an important step forward given the limited attention received from road haulage firms so far.

Several vendors signaled interest in taking on the assignment at LBC Frakt. However, their offerings typically reflected use of proprietary interfaces. The managing director of LBC Frakt therefore sent a letter to the MSI Group, officially criticizing its members for undermining the standardization effort (this was depicted as 'the revolution in Värmland' in the trade press). Although LBC Frakt was disappointed with the vendors, they appreciated the MSI group had developed into an official industry forum in which these issues could be addressed. They eventually selected two vendors on the mobile side and Locus Scandinavia for the stationary part of the digital infrastructure. During the integration process, the flexibility offered by the MSI context schemas caused considerable debate. Eventually, LBC Frakt concluded the standard provided too little guidance and decided to rely on Locus' proprietary interface because it had first-hand experience with it. Still, they were determined to support the open platform initiative and decided Locus' interface should be MSI-adapted through a project involving LBC Frakt, Locus, and TRB. The outcome was a solution for transport order management.

### Episode 3: January 2010 to April 2016 – Apps

Based on reactions from user organizations, a decision was taken to modularize the standard to support specific business processes. Seeking to leverage 'generativity' as the value proposition, researchers invited third-party players to plunge in and spur the modularization. After some consideration, platform members decided to cooperate with a third party actor specialized in route optimization. Such expertise was of particular interest to software vendors and truck manufacturers alike.

The shared platform initiative received considerable attention in the trade press and it was promoted heavily at several national road transport events by the members of the MSI Group. The marketing director of Pocketmobile, a rapidly growing vendor of mobile computing solutions at the time, talked about the positive industry impact it had:

> "MSIG offers its members a competitive advantage because it serves as mechanism that neutralizes competition from non-member firms. The more players are involved, the better it works. At the same time, however, there're probably a few more actors who should be part of it, but that's nothing we're actually complaining too much about…"

Informed by the LBC Frakt case, the MSI Group revised the standard to facilitate its diffusion into road haulage firms. The strategy was to modularize the standard into a set of core modules, and the LBC Frakt solution served as basis for the order module. At this point, however, the MSI Group faced considerable challenges when Hogia announced they had recruited TRB's MSI developer.

During spring 2010, researchers engaged individually and through the MSIG to implement the modularization strategy, namely a resource, a route, and a quality module in addition to the order module (Table 2). MSI Group members wanted the modules to be designed to support environmental sustainability. As the group lacked the required expertise, they engaged a PhD in environmental informatics from Chalmers University of Technology that at the time ran his own business, eco2win. In June 2010, the group initiated the development of the core modules together with DPS (vendor of route optimization technology) and Volvo. The development process took almost two years of iterative development with feedback from most MSI Group members.

The emergence of "Apps" as a new architectural vision, however, complicated the completion of the modularization of the standard and its subsequent diffusion. In fact, the truck manufacturers started to phase out gradually. Volvo had originally joined the initiative with the ambition to make it more international. However, the slow progress in combination with the clear focus on small Swedish road haulage firms meant that Volvo started to question its role in it. In the midst of everything, the platform initiative faced yet another emerging major technology architecture shift, namely Apps. The proponents of this architectural idea envisioned that apps would resolve many of the integration difficulties that plagued the transport industry in the past. Consequently, trying to secure its foothold in this emerging market, Volvo started to move away from the strategies the ongoing platform initiative pursued.

Platform members were still busy fine tuning the modularized XML-standard and did not pay enough attention to the implications the new technology architecture shift presented to them. Eventually other software providers started to lose interest as well. They felt they had achieved the goal of the platform initiative (their objective was to be able to integrate with other software in the market and have a better understanding of each other's software) and they realized a new technology integration landscape was emerging rapidly. In late 2012, the four modules were handed over to the MSI Group. Finally, during a meeting in May 2013 they decided to dissolve the platform initiative and members got back the rest of their membership fees. All the actors, however, continued their search for appropriate architectural solutions and strategies. Today, they all have adapted their architectures to make it possible for their products to support Apps implementations to different degrees.

## Discussion

Industrial products and processes are increasingly enabled by computing and communication capabilities based on digital sensors, networks, processors, and software. Given that the pervasiveness of such technologies reduces the gap between the digital and physical worlds (Lyytinen et al. 2002), organizations are able to store, mobilize, and interpret information sources unavailable in the past (Yoo 2010; Yoo et al. 2012). Smart trucks equipped with a GPS chip, two-dimensional barcodes, and RFID, for example, can send and receive information about their states, locations, and movements. These newfound information sources help logistic partners reshape and optimize their integrated supply chains by recognizing alterations in inventory levels, market demands, and transport constraints.

Such digitally enabled capabilities create opportunities for new behaviors not seen in the past, ultimately changing the concept of a service. However, although IT-enabled services are truly intangible, their co-production relies on processes that involve a complex array of heterogeneous and often autonomous technological and social elements. Technology standards can facilitate co-evolution of these items and thereby help build and sustain shared platform initiatives that afford industry players requisite opportunities to create new IT-based value in service delivery (Andersson et al. 2008; Lyytinen et al. 2008). Yet, we know little about the role of technology standardization in the longitudinal evolution of digitalization within specific industries where these standards enroll organizations into dynamic ecosystems that energize or inhibit the emergence of innovative services.

Against this background, my research concerns a shared platform initiative that led to a technology standard in the Swedish road haulage industry. From the start of the process back in 2002, the project aimed at diagnosing and resolving problems associated with the adoption of embedded, mobile, and stationary IT systems in road haulage firms. The main issue identified was the existence of proprietary, incompatible systems that were widely resisted by haulage firms (Andersson and Lindgren 2005). While technology vendors were reluctant to transfer knowledge and power to user organizations, the haulage firms had difficulties to prioritize strategic considerations mainly because of their focus on short-term execution of everyday operations. Indeed, the SRHA did not have a clear idea of how to support the ongoing digitalization of their members, which meant that calls from the researchers for help remained unanswered. Emergence of OSGi provided platform members with interoperability opportunities. It accelerated cooperation between competitor members of the consortia. However, it did not allow members to choose their level of data openness.

Later, however, the platform initiative experienced a breakthrough when Volvo showed interest in the project and asked members to join the shared platform. Not only did encourage the technology vendor community; it also brought haulage firms to the table because TRB Sweden saw this as an excellent opportunity to pursue the standardization agenda it had been promoting for long. Consequently, given the lack of standardized ways to integrate heterogeneous technologies into digital infrastructures, it was decided that IT vendors, haulage firms, transport industry representatives, and action researchers would jointly develop a technology standard (Andersson et al. 2008).

The introduction of the group to Web Services and XML standard encouraged members to work closer on the development of the platform and standardizing the interface. This architecture gave platform members the interoperability opportunities while giving providers more control over their openness degree. This decreased their perceived competition and accelerated the development procedure.

Thoughout the development process, the emerging standard served as a boundary object (Carlile 2002) that allowed the involved actors to reuse and reconfigure architectural knowledge embedded into current practices and to co-create visions for digital industry infrastructures. The different versions of the standard embodied the latest knowledge created and enabled continued conversations about innovative business processes. Hence, the standard was shaped iteratively through an unfolding industry ecosystem in which individuals and organizations alike engaged in perspective making and perspective taking (Boland and Tenkasi 1995) to learn from each other, while at the same time maintaining their own understanding (Boland et al. 2007). That is, the process was shaped through the identities and core competencies of the involved actors and how that in turn reshaped the relationships between them. While the boundaries between vendors of embedded, mobile, and stationary technologies initially were anything but clear, the establishment of MSI Group helped create transparency and facilitated new patterns of cooperation. Indeed, this standardization consortium helped its members position themselves, ultimately creating better conditions for joint implementation projects. However, the knowledge they gained from each other's business processes and platform architectures did not have desirable outcomes for all members involved e.g., it threatened Hogia's business strategy in episode 2.

Clearly, a key outcome of the standardization process was the establishment of the MSI Group. As a commercial consortium of vendors of embedded, mobile, and stationary transport systems as well as truck manufacturers and road haulage firms, the group made the MSI standard available to the Swedish road transport industry. While there are examples of road haulers that have completed MSI-based integration projects, the standard was also increasingly present in situations where such firms requested offerings from vendors.

Modularization of platform architecture motivates higher generativity degree (Yoo 2012) however shared platform governance should not allow for a third party to get control over the interface design. Such governance practices threaten platform's evolution. Adopting the design for complementors should not take the center stage so

that the design of platform misses the technological shifts in the industry. Such precautions are of higher importance for shared platform there compatibility of platforms is the reason of shared platform existence.

Several IT vendors have implemented the standard in their software packages, and truck manufacturers have promoted it globally throughout their organizations. Despite the platform not being used, the MSI Group was seen by many as a nexus of digital innovation in the road transport industry. The group represented a physical and cognitive arena that operated at the industry level and catered for value-creating interactions that transcended structural boundaries previously undermining complementary approaches.

My presented analysis of coopetitive dynamics within the MSI initiative suggests shared platforms can serve as a neutral arena ("trading zone") for actors to cooperate with their competitors with periods where these two modes of interaction are overlapping and periods where one of these two is dominating. Shared platform members who undertook competitive behaviors within coopetitive activities when they sought to develop a standard that would create value for all involved parties characterized the platform dynamics. My analysis traced this coopetitive dynamic through platform evolution and identified the emerging technology architecture shifts that challenged enacted governance strategies, ultimately leading to dynamic patterns of coopetition in the platform ecosystem over time (Gawer 2014; Tiwana 2015). Table 4 illustrates my findings based on Gawer's (2014) framework together with actors' motives and end point of each episode.

| Episode | Coordination of Agents | Value Creation | Technological Architecture | Motivations | End Point |
|---|---|---|---|---|---|
| Episode 1: April 2002 to April 2004 – Open Services Gateway Initiative (OSGi) | • Forming a federated group of heterogeneous actors through "Value-Creating IT for Road-Haulage Firms" initiative.<br>• Inviting different sides of platform's market to the open platform design<br>• Initiate the open platform initiative from the user side to balance the competition between providers.<br>• Excluding TMS providers to transport buying companies as to be able control and balance heterogeneity degree and innovation. | • Facilitating access between different sides of the platform<br>• 'Compatibility' between ecosystem platforms' technology architecture | • Proposing Vehco's OSGi open modular architecture as the core | **Haulers:**<br>• A comprehensive system to cover all the transport working process<br>• Being able to transact with other haulers<br>**Truck manufacturers:**<br>• Being part of the open platform design group<br>• Understand technology ecosystem's coopetitive dynamics to be able to expand their platform<br>**Software vendors:**<br>• Being part of the open platform design<br>• Becoming able to communicate and transact with other sides of the platform | • Increased competition between different platforms present at the initiative<br>• Even platform in collaborative relationships with Vehco were threatened by relying on another platforms architecture as an industry platform. |
| Episode 2: May 2004 to December 2009- Web Services (WS) | • Doing research and coming up with a modular technology architecture that fit the ecosystem coopetitive dynamics<br>• Lead the standardizing of the interface facilitating innovation and future evolution of the platform<br>• Branding the open platform initiative to increase direct and indirect network effects by increasing the size of participants from different sides of the platform | • Increasing network effects<br>• 'Utility' of the integration standard for user organizations (road haulage firms). | • Web Services: The modular architecture of MSI web services hosted on MSI website at the core, the WSDL specified for MSI as the interface and communication of different XML message kinds as the periphery | **Haulers:**<br>• Increasing positive network effects<br>**Truck manufacturers:**<br>• Being part of the open platform design group<br>• Learn more about the platforms ecosystem in the industry sector<br>• Strengthen indirect network effects<br>• Make sure the ecosystem coopetitive dynamics together with strong network effects does not end up in "winner-take-all" situation in favor of their rival.<br>**Software vendors:**<br>• Being part of the open platform design group<br>• Make sure the ecosystem coopetitive dynamics together with strong network effects does not end up in "winner-take-all" situation in favor of their rival.<br>• Figuring out other complementors or competitors core technology architecture to be able to complement them to gain competitive advantage | • Realizing the need for modularizing the design even at interface level so that the complexity of different parts can be isolated to components. |
| Episode 3: January 2010 to June 2016- Apps | • Taking heterogeneity of complementors in to account by focusing on niche-focused efforts<br>• Managing the niche-focused contributions to greater collective benefits of the ecosystem<br>• Trying not to jeopardize the ecosystem health, created a control-generative balance | • Increasing network effects<br>• Facilitate generativity and continuous innovation by adding the parameters needed to the standardized interface | Apps: An architecture that allows platforms to communicate via standardized interfaces irrespective of device | **Haulers:**<br>• Make sure the technology architecture modularization effort cover the heterogeneous environment on demand side<br>• Make sure the modular design for route-optimization guarantees a control-generativity balance<br>**Truck manufacturers:**<br>• Learn more about the platforms ecosystem in the industry sector<br>• Get more knowledge on route-optimization<br>**Software vendors:**<br>• Being part of the open platform design group<br>• Advocating an architectural design that doesn't limit generativity | • Platform owners learning about the ecosystem coopetitive and technological dynamics which has affected the technology ecosystem maturity level positively. |

**Table 4 Analysis of MSI key episodes**

My findings suggest actors in technology intensive industries need to strategize for the emergence of shared platforms, even before stable industries are formed through the diffusion of technology standards. Network effects (Suarez 2004), entry of start-ups with new technologies (Anderson and Tushman 1990), and the influence of complementors (Teece 2007) and others in institutional fields typically characterize such platforms (Garud et al. 2002). Here the level of uncertainty experienced by actors is likely to be higher than during the era of incremental change, and some have suggested that the speed of change is also significantly higher (Christensen et al. 1998). My findings further suggest this era requires significant vigilance and agility on the part of participating actors. They need to continually scan and monitor their own ecosystems and other relevant ecosystems to learn about developments in

the product market sector as well as the relevant technical and institutional sectors. They also need to be agile in their responses to their competitors to successfully embrace the inherent logic of platform coopetition (Gawer 2014; Tiwana 2015).

The lessons I have learned also indicate that the engagement in shared platform coopetition requires actors to devise their strategic positions properly in the technological landscape. A key issue in platform initiatives is the timing of players' entry into the platform or the technological field (Christensen et al. 1998; Suarez and Utterback 1993; Tegarden et al. 1999; Wareham et al. 2014). These actors are confronted with the challenge of predicting future technology architecture shifts, which is a genuinely difficult task given the competitive uncertainty characterizing technology change processes. Suarez (2004) argues very few technologies today can work in isolation, and some form of cooperation with other technologies is usually required to advance a sustained competitive advantage. My findings show that such platform coopetition (enabled by technology standards), however, can reduce resource heterogeneity in an ecosystem that eventually may culminate in intensified competition between cooperating actors. This form of competition mainly originates from technological changes that enhance a firm's capability and position while they render one or more coopetitiors' capabilities obsolete (Afuah 2002).

## Conclusions

Interplay between innovation and social aspects are key feature of platforms. This study advances our understanding of sociotechnical dynamics of shared platforms: The emergence and dynamics of shared platforms that is highly affected by the interplay between coopetition and technology architecture. My study shows complex, interacting, and contradicting actions by an array of heterogeneous actors and architectures form the design of the shared platform. However, this dynamism should be met with proper governance strategies through technological shifts otherwise it turns coopetition relationships into intensified competition. Previous studies on industry platforms have mainly illustrated homogenous milieus while I have contributed a detailed empirical account of how a heterogeneous ecosystem of players within the Swedish haulage industry created a shared platform initiative to exploit the commercial possibilities afforded by integrating embedded, mobile, and stationary IT solutions through new industry-

wide infrastructures. This offers a contribution to existing research and offers what Walsham (1995) calls "rich insights" on shared platforms.

The MSI project has been the only place for Swedish road haulage industry actors to cooperate in favor of customers, to this day. Although, ecosystem's platforms are not using the MSI as the communication platform today it played a major role in accelerating integration projects by stabilizing cooperation between actors. However, my results show that letting complementors hijacking shared platform development and inability to meet technological shifts hindered this initiative to hit diffusion. This offers important implications for Innovation leaders managing such shared efforts or actors planning to join standardization consortia. In addition, my analysis shows shared platforms are result of reciprocal action between coopetition dynamics between heterogeneous actors, competing platforms and constantly changing technology and industry dynamics which if governed properly lead to value creation.

## Accepted works

Saadatmand, F., & Lindgren, R. (2014). Technology standardization for transport efficiency: on the greening of frames (extended abstract). IFIP WG8.2 Organizations and Society in Information Systems (OASIS) 2014 Workshop

Saadatmand, F., & Lindgren, R. (2015). The Tension between Stabilized Cooperation and Intensified Competition: Greening of Technological Frames in Practice. JAIS Theory Development Workshop

Saadatmand, F., & Lindgren, R. (2016, January). The Tension between Stabilized Cooperation and Intensified Competition: Greening of Technological Frames in Practice. In 2016 49th Hawaii International Conference on System Sciences (HICSS) (pp. 327-336). IEEE

Saadatmand, F. (2016). Open Platform Coopetition: The Paradoxical Tension between Stabilized Cooperation and Intensified Competition. European Conference on Information Systems (ECIS) 2016 Doctoral Consortium, June 2016

Saadatmand, F. (2016). Open Platform Coopetition: The Paradoxical Tension between Stabilized Cooperation and Intensified Competition. Organizational Communication and Information Systems/ a division of Academy of Management (OCIS) 2016 Doctoral Consortium, August 2016

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