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# **Architectural knowledge: key flows and processes in designing an inter-organisational technological platform.**

Amel Attour, Maelle Della-Peruta

## **Abstract:**

The main objective is to identify which knowledge flows are key elements for designing an inter-organisational technological platform. It mobilizes two theories: the literature of platform strategies and the architectural innovation theory. In the literature, the technological platform is already existing, is the property of only one firm and it is the starting point for an inter-organisational innovation process because it is enhanced and enriched by niche players. This paper considers the case of a digital business ecosystem where the technological platform doesn't already exist and it is co-designed. We study the design process of an inter-organisational technological platform and, more specifically, its emergence, its development, and its potential evolution. The issue is to know how and under which conditions and with what objective an emerging technological platform is fundamental to the analysis of the emergence of the business ecosystem and the strategic positioning of each member.

**Keywords:** Digital business ecosystem, architectural innovation, architectural knowledge, knowledge flow, technological platform.

# **Architectural knowledge: key flows and processes in designing an inter-organisational technological platform.**

## **INTRODUCTION**

Knowledge is a precious and critical resource for organizations, particularly in the current information society. It has become a key asset and an important competitive edge for organizations which are more intent on knowledge than on labour (Nonaka, 1991). Although the definition of knowledge has been largely debated, a precise description of knowledge has not been proposed. Several taxonomies have however been built which make the distinction between tacit-codified, individual-collective, private-public, component-architectural and complementary-supplementary knowledge. Regarding these taxonomies, as it flows, knowledge can be tangible or intangible. As Nissen (2005) explained, knowledge is a competitive resource for which capitalization depends upon its flows. In the knowledge management literature, several works have developed static and dynamic models representing the phenomenon of knowledge-flows and how they can be managed. From a technological point of view, Leavitt (1965) and Davenport (1993) explained that knowledge flow needs the existence or the design of information systems (IS) along with corresponding organization and process characteristics.

In this paper we ask whether knowledge as a tangible asset could contribute to the elaboration of the IS destined to facilitate such knowledge flows in a collective innovation context. In other words, the present research uses the taxonomy component-architectural model to analyse the role of knowledge flows in designing an inter-organizational artefact. It focuses on the “business ecosystem” concept introduced by Moore (1996), defined as a collaborative space dedicated to innovation and which is characterized by strong interdependencies between firms from different sectors. In such a complex inter-organisational environment, technological platform structures the business ecosystem (Iansiti and Levien, 2004; Gawer and Cusumano, 2002; Isckia, 2011). In the industrial sector, for instance, the platform is associated with a subsystem which is the core global system and it provides flexible coordination via interfaces between components produced by specialized firms (Baldwin and Woodard, 2011). This is the case of Microsoft Windows and Linux, Intel and ARM microprocessors, iPod, iPhone and iPad by Apple, game consoles, debit cards, etc. The platform is the starting point for an inter-organisational innovation process (Iansiti and

Levien, 2004). However, few works have highlighted the reasons why technological platforms are the basis of a business ecosystem (Parker and Van Alstyne, 2005; Hagi, 2007a and 2007b; Gawer and Cusumano, 2012).

In the following, we address the design process of the technological platform for the new digital business ecosystem, more precisely the new Near Field Communication (NFC) ecosystem. As Madlmayr et al. (2008) explained, in the NFC ecosystem several technical and strategic issues have to be dealt with to enable its emergence. From this point of view, the present research aims to analyse how knowledge-flows contribute to resolve these issues. The main objective is to identify which knowledge flows are key elements for designing an inter-organisational technological platform. As a first step, we identify the role of a technological platform in a digital business ecosystem, and particularly its main characteristics. Secondly, we use architectural innovation theory (Henderson and Clark, 1990; Anderson *et al.*, 2008) in order to develop an analysis grid which is helpful in identifying and analysing the role of architectural knowledge in the technological platform design. After presenting our methodology and our experimental work- *technological platform based on Near Field Communication (NFC)*- in a third part, we discuss our results in part 4 and show that architectural knowledge comprises key flows and processes that structure the emergence of the digital business ecosystem.

## **TECHNOLOGICAL PLATFORM TYPOLOGY: THE CONDITIONS FOR THE EMERGENCE OF AN INDUSTRIAL TECHNOLOGICAL PLATFORM**

According to the typology outlined by Gawer and Cusumano (2012), technological platforms may be “internal” or “external”, closed or open. There are three types of platforms: internal, supply-chain and industrial.

Internal platforms are “*a set of components organised in a common structure from which by-products may be efficiently developed and produced*” (Muffato and Roveda, 2002). According to Gawer (2010), Gawer and Cusumano (2012), an internal platform may evolve into a “supply-chain platform”. In this case, the platform is a key tool which can improve firms’ productivity by reducing costs related to the regular use of modular components. They can

also provide the firm with access, at lower cost, to the new innovations, technologies, or essential components that it cannot control.

Internal and supply-chain platforms are different from industrial platforms. Firstly, the nature of relations (commercial or otherwise) between the firms involved is different. In the case of industrial platforms (external platforms, called open platforms), firms develop complementary innovations and they are not necessarily bound by a client-supplier relation. They are part of the same value chain and share the same market strategy, like the Windows and Apple apps. The product, service or final use can be incomplete, sometimes deliberately. This product is not predefined but is dependent on its level of openness, in particular its capacity to attract external actors to innovate and enrich the value proposition of the platform. Secondly, demand is for the whole system which creates value for the set of components while each component separately could not attract demand (Gawer and Henderson, 2007). The platform interface must be open enough to enable external actors – *outside firms* – to enrich it by addition, innovation or development of complementary assets. This third characteristic determines the development of niche activities and, in consequence, survival of the ecosystem (Iansiti and Levien, 2004). However, not every product, service or technology can fulfil the role of industrial platform. A number of conditions need to be in place for an industrial platform to emerge.

It can firstly be an internal platform and switch to a supply-chain platform and/or an industrial platform provided that three conditions are fulfilled (Gawer, 2010, p.28):

- i. External firms can enrich the value of the platform's components,
- ii. The value for customers is created less by the assembler of components than the components themselves,
- iii. Component actors can benefit from different market opportunities as before.

More generally, the emergence of an industrial platform-ecosystem must meet with certain conditions (Gawer and Cusumano, 2012; Iansiti and Levien, 2004):

- Identifying how a product, a technology or a service may become the structuring element of the business ecosystem;
- Creating a technical platform with good connectors;
- Defining an innovation way to evolve shared with niche players who will contribute to the co-creation of the business ecosystem;
- Allowing the platform to evolve, maintaining the “vibrancy” of the business ecosystem.

In order to show how architectural knowledge flows contribute to achieve these conditions, we use the Anderson *et al.* model (2008).

## **UNDERSTANDING THE ROLE OF ARCHITECTURAL KNOWLEDGE IN THE DESIGN PHASE OF AN INTER-ORGANISATIONAL INNOVATION: THE ANDERSON ET AL. MODEL (2008)**

Inter-organisational innovation in the ICT sector is based on independent and existing technological systems or matching bases (connection) which constitute components of a larger architecture (Ulrich, 1995; Baldwin and Clark, 2000). This architecture is a set of components, acquired, applied, developed and improved in the long-term and implemented in a specific place in a product's system with the help of a core design concept (Henderson and Clark, 1990). A spell of exchanges and negotiations is necessary during an architectural innovation process in order to identify the dominant product or system architecture (West and Dedrick, 2000). These negotiations are oriented by specific knowledge, called architectural knowledge, stored in existing computerised structures and systems (Henderson and Clark, 1990). When innovation is resulting from an inter-organisational process, two or more components are interconnected. There are components able to separately provide a set of specific uses which provide value creation for the customer or the final user. These components are composed of a base system, knowledge (called "component knowledge"), industrial relations, and they are bought on a specific market. Their interconnection is facilitated by a collective action from two or more firms which operate on different markets, and it needs an architecture design to promote a match between heterogeneous technologies which were initially independent components (Anderson et al. 2008). This collaborative innovation process is based on essential prerogatives: the development of channels and communication filters between actors and the instantiation of the four dimensions of heterogeneous actors of architectural knowledge. These four dimensions enable the study of the necessary conditions for the design process of an inter-organisational innovation. They are indispensable to create exchange places where heterogeneous actors meet each other and negotiate the matching of their technologies (Kellogg *et al.*, 2006).

The first three dimensions are a subset of architectural knowledge. They are:

- '**Technology capability awareness**' is the actors' awareness of the components' technology capability. This awareness is made possible by previous experiences related to these components.

- ***'Use context sensitivity'*** is the understanding of the context in which a specific component is deployed. The sensitivity is the understanding that many innovation contexts exist and can be mobilised.
- ***'Business model understanding'*** is the evaluation of market opportunities related to the applications of a component.

The fourth dimension - ***'Boundary-spanning competence'*** (relational competence) - is the ability to develop the first three dimensions (Anderson et al., 2008, p.35). This fourth dimension represents the resources and the competences used and engaged in a collective process where heterogeneous firms redefine their knowledge of components in order to associate them with other components (other firms' components) and to co-develop architectural knowledge. It depends on good relationships between firms and good inter-firm information exchanges (Van de Ven, 2005). The lack of *'boundary-spanning know-how'* can slow down their co-creation and inter-organisational innovation. If there is no leading actor (or it is not identified), the role of the relational dimension of architectural knowledge is essential. This dimension can take the form of a platform strategy with a neutral solution promoting the emergence of architectural knowledge. This role must be fulfilled by neutral actors, according to Anderson et al. (2008), such as public institutions (universities, research centres, industry associations).

We propose to apply the Anderson et al. (2008) model to the case of an emergent digital business ecosystem with no pre-existing technological platform.

## **METHODOLOGY**

Our analysis is based on a case study involving an exploratory research. In fact, according to David (2004), mobilising one or more cases is interesting *"when the questions asked are "how" or "why" about a set of contemporary events and on which the researcher has no control"* (Yin, 1989, p.20). In our case study we analyse the design conception of a technological platform produced through an inter-organisational innovation from the **Financial Inclusion based upon Rural ubiquitous Services Technological platform (FIRST)** project, co-founded by the University of Nice Sophia Antipolis (UNS), more precisely its Master MBDS with laboratories I3S and GREDEG-CNRS-UMR 7321, and Tata Consultancy Services (TCS), a service company in Information and Telecommunication (IT) engineering

specialised in IT and software development. The empirical case is studied in order to question and to test pre-existing theoretical notions used to validate them empirically.

### **- Exploratory research based on a case study**

The epistemological stance adopted is constructivist, allowing “*the knowledge legitimisation built with interpretation and data management (...) and with the mobilisation of existing knowledge – i.e. knowledge which its legitimisation is known by the researcher -, under conditions of transparency, ethic and epistemic and empirical rigour*” (Gavard-Perret et al. 2012, p.34). We chose to collect our data by active observation in line with David (1999) and Chanlat (2005). This method is pertinent when the researcher status is known in the observed organisation and, furthermore, because our data are collected without intervention in the studied phenomena (Savall and Zardet, 2004).

More precisely, our approach is characterised by several switches back and forth between theory and the case study in order to underline their complementarity and to add new elements to the theory. This stance was respected in all three research parts: theoretical research, interviews with experts, and the case study. The two main theoretical axes of this research (technological platform strategy and architectural innovation theory) were built as the interviews were conducted. Data collection was performed in several stages and manners: observation, document analysis (secondary data: analysis of technical documents given by practitioners, activity reports, and online information collection, etc.) and semi-directive interviews (primary data). Based on our participating observation, we collected precious primary data lasting the 7 meetings (about the proposed work bringing out the innovative approach planned to be tried, the proof of concept, the position of the proposal vis-à-vis existing and emerging scenario, scheduling and mechanism of interaction, the management of intellectual property, etc.) in whom we had participated in all the phases of FIRST’s project definition. We were also members of e-mails exchanged between all FIRST partners since the idea emergence of the project. We secondly completed our primary information thanks to semi-directive interviews lasting about one-and-a-half hours with practitioners (3 interviews) and on our participation in setting up the project’s meetings and negotiations. The semi-directive interviews conducted with the project manager of the 3 directly implicated actors in FIRST platform deployment had the main objective to confirm and complete the subjects we had identified. As our primary data are principally based on our participating observation, interviews with the 3 project managers of each actor that contribute to the deployment of FIRST’s platforms were sufficient to the findings validity.



The final subject analysis (Bardin, 2003) resulted in identification of 8 themes (business ecosystem, business model, open innovation, platform strategy, alliance, architectural knowledge and innovation, co-design, digital territory) consolidated into 2 themes (technological platform and architectural innovation theory) used to analyse our primary and secondary data.

### **- The case study: FIRST project**

The goal of the FIRST project is to develop a generic system based on NFC technology in order to distribute a set of banking services via a media accessible to the rural Indian population: the mobile phone. According to the Indian Ministry of Finance (2011), 47% of the Indian rural population (compared with 80% in urban zones) has at least one mobile phone per family. FIRST project mobilises 4 actors: Tata Consultancy Services (TCS), the Indian Institute of Science de Bangalore (IISc), the Master MBDS of UNS and GEMALTO.

More precisely, FIRST aims to deploy a generic platform which solves problems in the *Public Distribution System* (PDS), then to move on to a set of virtual service offerings for the Indian rural populations who have no access to banking services. The Public Distribution System is a public aid system relating to the consumption of basic products (rice, wheat, kerosene, etc.) provided by the Indian Government, via private retail outlets ("*Fair Price Shops*") to enable poor people to access these products at a subsidised price. The innovation trajectory of FIRST has social and economic goals ("*from financial inclusion to rural inclusion in India*", Debi Pati, Project Manager TCS). Technologically, FIRST aims to ensure interoperability between two solutions based on different industrial infrastructures (banking infrastructure and telecoms infrastructure). This sectorial convergence raises a lot of issues about the ecosystem actors' strategic positioning (Basole, 2009) and about the business model of the services offered.

The technological platform deployed by FIRST in July 2011 contains a virtual account to register platform users. These can access to their account via a NFC compatible mobile phone (Smartphone) sold locally, a Bluetooth NFC sticker which makes every non-NFC mobile phone compatible with this technology, or with the help of an electronic card (the Indian Government can distribute these cards to benefit PDS users). This virtual account enables numerical identification of users and access to data about them (to know the food rights of users in the PDS, for example).

The FIRST platform enables the dematerialisation of transactions between two groups of agents: a beneficiary of PDS and a manager of a Fair Trade Shop sustained by the PDS

scheme. Both agents are respectively equipped with a Smartphone and a NFC tag reader which is a sticker or wristband with small microchips that can be read by in range mobile devices. Food products distributed via PDS are tagged with a NFC code. When a tag is read, a secure identification process enabling exchanges starts up (virtual coupons exchanged for food products). In the case of a banking service, the process will be the same: a dematerialised payment transaction starts up, aided by the users' Smartphone or NFC sticker when banks read the NFC tag.

This platform design needs a connection between technological solutions based on existing systems and characterised by extensive market penetration and by a technical architecture design which enables their connection. The next part analyses this design process helped by our analysis grid proposed in our theoretical framework.

## **THE ROLE OF ARCHITECTURAL KNOWLEDGE IN THE FIRST PLATFORM DESIGN**

In this part, we will demonstrate that the FIRST platform design is a supply-chain platform which will evolve into an industrial platform thanks to the actors' architectural knowledge.

### **-FIRST, design of a supply-chain technological platform: the role of previous architectural knowledge**

The objective of FIRST design is to combine two core components. Each component is provided by an actor in the project. The first component is the Gemalto's Trusted Secure Manager Over the air (TSM-OTA). This component makes the interface with telecommunication operators providing the secure element of the FIRST solution. It also ensures the security of private data exchanges (user identification, rights management, etc.) between FIRST solution's secure element and the TCS's financial TSM (the second component) which providing a secured interface between users and banks.

*“This architecture will be based upon two TSM's (Trusted Service manager) to be as open as possible with symmetric role expected by banks and Mobile Network Operators (MNO). These 2 functional TSMs' are “core” and “NFC business enablers”. There are a financial TSM-FIRST open to any bank (operated by TCS) and a telecom TSM- OTA, provided by us, open to any MNO.” F. Lemaire, Gemalto.*

This architecture is composed of two core components developed and tested previously by two actors - Gemalto and TCS – bound by commercial relationships (customer-provider). The component of TCS, which is the leader in India, is based on its expertise in integration system development of software and in customer relationship management. Gemalto provided its TSM-OTA solution, legitimized by its global renown on the numerical transactions security market. The combination of these two components was made possible thanks to the generic architecture designed by UNS in the form of a standard (a set of norms) which describes system functioning rules, links, and possible interactions between components. In fact, the FIRST platform design development by UNS is based on its know-how in development of NFC platforms supporting an offer of territorialised and dematerialised services (several projects have been implemented since 2009).

*“Given the projects developed by UNS in NFC platform, the idea was to capitalise on these developments, to generalise them in order to define a generic architecture suitable for FIRST and other services in the framework of FIRST or other service offers.”* Benjamin RENAUT.  
Project Manager, UNS.

By defining system functions, i.e. interactions between its components, and by planning possible changes, UNS designs the *core design concept* of the FIRST platform which creates an exchange area that enables TCS and Gemalto to inter-connect their architectural knowledge within the meaning of Anderson et al. (2008) and Jaspers F. et al. (2012). The FIRST platform design is thus an architectural innovation with a *core design concept* (Henderson et Clark, 1990) deployed by UNS and with a known final product which connects Gemalto and TCS components.

According to these elements, the FIRST platform can be characterised here as a supply-chain platform (table 1).

**Table 1. First supply-chain platform characteristics**

<b>FIRST: a supply-chain platform</b>	
<b>Actor</b>	<b>Component</b>
TCS	<ul style="list-style-type: none"> <li>- Solution TSM for banks: Financial TSM</li> <li>- Virtual accounts for final users</li> <li>- Interfaces web, NFC</li> </ul>
GEMALTO	<ul style="list-style-type: none"> <li>- Solution TSM-OTA which enables the interface with telecommunication operators (MNO) : Telecom TSM-OTA</li> <li>- SIM cards (secure element) and NFC stickers</li> </ul>
UNS	<ul style="list-style-type: none"> <li>- Technical architecture</li> <li>- NFC tags reader and interfaces web, NFC</li> </ul>

In definitive “*Boundary-spanning competence*” comes from UNS which is a neutral actor because of its function as a public research institution (Anderson et al. 2008). However, this platform will evolve. In the event of success, the objective of the FIRST project is to develop a technological NFC platform to solve problems of low penetration of banking services in India. The next part studies the conditions which allow this evolution.

**-FIRST, from a supply-chain platform to an industrial platform: the role of each dimension of architectural knowledge**

The openness of the FIRST supply-chain platform to the banking market requires some conditions identified by ecosystem actors and based on specific architectural knowledge. First, they identify the structuring element of the platform. The second objective of FIRST is to position itself as a solution to the problems of financial inclusion in India. In this regard, the secure financial element of TCS (financial TSM) is the central component of the FIRST platform. In fact, two dimensions of architectural knowledge acquired by TCS on its component give the FIRST ecosystem the possibility of opening its platform to banking services and commercial transactions (“technology capability awareness” dimension). This possibility of developing banking activities via the FIRST platform was revealed thanks to the “use context sensitivity” dimension of TCS. TCS analysed the particular context of this country (problems of fraud and black market of PDS (Reserve Bank of India, 2010) and financial inclusion issues in India (Word Bank, 2011)). To solve these problems, TCS wants to use the FIRST platform, to develop secure banking services via mobile phones (bank account, credits, savings, and payments).

*“This solution would address the 10 features of Financial Inclusion program concern (cf Jaipur Conference): cash deposit/withdrawal, immediate credit, saving product, remittance and*

*payment services, life assets, mortgage, entrepreneurial credit, advisory services, enabling welfare payments to the poor under various welfare schemes, and pension for elderly and financial plan for children. In going forward, the solution landscape will be capable of supporting value added services envisioned in later point time.”* Debi Pati, TCS

Potential niche activities and innovation trajectories shared with the others members of the FIRST ecosystem, which are essential conditions for an industrial platform design within the meaning of Iansiti, Levien (2004) and Gawer, Cusumano (2012), were identified by TCS from the outset thanks to two dimensions of architectural knowledge acquired on its financial component (“use context sensitivity” and “technology capability awareness” dimensions). TCS also wants to develop this platform in other emerging countries where the company already has branches.

*“In case of success, large dissemination in rural India and emerging countries (Morocco, Tunisia, Haiti, Vietnam, Nigeria, Russia, Brazil ...) could be envisioned by TCS and other software house partners (already identified in these countries)”.* Debi Pati, TCS

The evaluation of market opportunities by TCS (and by its architectural knowledge, “business model understanding”) enables the FIRST platform to open and enrich its value proposition and to be deployed in markets other than the initial market for which the supply-chain platform has been designed. The role of UNS as assembler is no longer the element which creates value or the structuring element of the platform. The financial TSM is the structuring element of the platform. It becomes the core element in the industrial version of the FIRST platform which enables external firms to enrich the value proposition of the platform, and the role of the assembler is less important than the value created by the TCS component. The interactions and strategic positioning of the FIRST ecosystem actors change. In its industrial form, TCS becomes the leading actor of the FIRST platform because it provides the structuring component. By connecting to the financial TSM, banking actors and other potential actors enrich the value proposition and position themselves as niche actors. The relation between niche actors also requires the TSM-telecom from Gemalto which maintains its commercial relationship with TCS and remains the TSM-OTA solution provider in the FIRST project.

**-FIRST key architectural knowledge and its mains flows and processes in the industrial technological platform design**

As summarised in table 2, two dimensions of architectural knowledge have been identified here as key flows in the design process of the FIRST industrial technological platform: the “use context sensitivity” dimension of one or more members and the combination of component knowledge.

**Table 2. The role of architectural knowledge as flows in designing an industrial technological platform**

Conditions	Means employed by FIRST actors	Architectural knowledge mobilized
<b>Structuring element</b>	The financial TSM (TCS)	TCS’s Technology capability awareness
	Banks and local service providers are identified by TCS as potential niche players	TCS’s use context sensitivity
<b>Designing a technological platform</b>	The architecture developed by the UNS is going to be put on open source in order to allow the connection of niche activities	TCS’s use context sensitivity
	Intellectual property rights (IPR) of a component remain with its owner Shared IPR are concluded only when foreground IP are jointly developed	Component knowledge of each actor
<b>Defining an innovation trajectory</b>	The FIRST platform is the back office support of a mobile services package which can be continuously enriched	TCS’s Business model understanding

*Adapted from Gawer and Cusumano (2012), Iansiti and Levien (2004)*

With FIRST, the first role concerns architectural knowledge-flows from TCS to other members of the ecosystem. The second is a combination of components provided by all the actors thanks to UNS’s relational competences and its *boundary-spanning competence*. This combination is linked by the UNS generic platform. The role of the UNS is not sufficient because the connection between the financial and the telecommunication TSM needs to share intellectual property (IP). However, with FIRST, the collaborative agreement between the three actors specifies that “*all background IP of a party shall remain the sole and exclusive property of such party*” and that “*each party shall own the foreground IP which is developed or which arises as a result of that party performing its obligations pursuant...For any joint Intellectual Property Right (IPR) made under this agreement, the parties (...) shall jointly own such IPR*”.

As Gawer and Cusumano (2012) show in their research, sharing both background and foreground IPR is however a key flow in the design process of a technological platform. The first agreement concluded between FIRST actors (the exclusive IP of components provided by each actor) was clearly going to impact the evolution of the platform from supply-chain to industrial. It was also going to highlight the complexity of the FIRST business model or, conversely, to structure it.

## **CONCLUSION**

This research studied the essential conditions for an inter-organisational technological platform design. Contrary to what is often seen in the leadership and business ecosystem literature, it analyses the situation where the structuring element of an inter-organisational innovation is not provided and is co-constructed by actors of its ecosystem. As we show in the study of FIRST project, the inter-organisational design of a technological platform is based on architectural knowledge flows diffusion between the ecosystem's heterogeneous actors. This platform can take several forms. Its evolution needs identification of the structuring element, a component of the supply-chain platform for example, which will structure the industrial platform. The innovation trajectory of the platform is defined by the leading actor and it must define a strategic vision shared by the members. These conditions are realized, as we can see with FIRST, thanks to architectural knowledge flows between actors. It is these knowledge-flows which enable a technological platform to move up from supply-chain to industrial platform, contributing to the emergence of a digital business ecosystem. Firstly designed as a supply-chain platform, FIRST evolves into an industrial platform thanks to architectural knowledge held and shared by TCS and to a generic platform deployed by UNS.

These results contribute to the platform strategy literature in two ways. It first show that in the new telecommunication ecosystem (Basole, 2009), the core element (the technological platform) of the business ecosystem could be designed in an inter-organisational way. This design process should be the main condition of innovative mobile services success, because it solves important coordination problems between stakeholders. More precisely, as we see in our case study, FIRST platform is based on two components that are the property of two leaders in their industrial sectors: Gemalto and TCS. In order to make possible the inter-connexion between these two components, one dimension of architectural knowledge played a key role: UNS's "boundary-spanning competence". This UNS's architectural knowledge resolves important coordination problems that characterize the new digital business ecosystem. These results highlight secondly that in platform-ecosystem, when the

technological platform is of type industrial, the role of a neutral actor and the role of architectural knowledge flows are two key conditions of any digital business ecosystem emergence. More precisely, besides the four conditions pointed out by the traditional platform strategy literature (Gawer and Cusumano, 2012; Iansiti and Levien, 2004), “boundary-spanning competence” dimension of architectural knowledge is one more key condition of any industrial platform-ecosystem emergence. In definitive, firms have to consider the key role of a neutral and public actor in the design of an inter-organizational platform, especially when the business ecosystem has not yet a leader (Anderson et al. 2008).

From a managerial point of view, the present research highlights three points. First, it shows that architectural knowledge represents key flows in the inter-organisational design process of a digital business ecosystem’s technological platform. We can distinguish two phases. The “use context sensitivity” dimension of architectural knowledge have in fact a key role in only the birth phase of the business ecosystem (the co-design phase of the business ecosystem’s core element). The main success condition of this first phase is the key role played by a neutral actor’s (a public research institute for example) “boundaring-spanning competence” dimension of architectural knowledge as discussed earlier. In the expansion phase of the business ecosystem, two dimensions of architectural knowledge acquired on FIRST’s financial component (“business model understanding” and “technology capability awareness” dimensions) meet with two main conditions allowing the emergence of any industrial platform (defining an innovation trajectory shared with niche players and maintaining the “vibrancy” of the business ecosystem). We believe that these two architectural knowledge flows should position their owner as the leader in the expansion phase of the business ecosystem.

Secondly, the present research pointed out the main role of IPR. FIRST platform will successfully evolve into an industrial platform if the share of IPR is not limited to foreground IPR but includes background IPR. Third, it also points out that a digital business ecosystem may emerge if both background and foreground IPR are shared. In conclusion, Knowledge-flows can be shared in a collective innovation context; however, in a commercial and industrial phase these flows can be slowed down, notably because of IPR. Sharing both background and foreground IPR is however a key flow in the design process of a digital business ecosystem’s technological platform. Conversely, licensing the use of partners’ background IP and foreground IP may facilitate the elaboration of the platform’s business model. It will therefore be interesting to analyse in future research how not sharing the IPR of



an inter-organisational platform will not hinder the emergence of a digital business ecosystem but contribute to enhancing crucial sources of value creation for its business model.

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