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IOS project motivation as a determinant of project activities and business capabilities

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GENERATIVE MECHANISMS FOR INNOVATION IN INFORMATION INFRASTRUCTURES

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Abstract

This paper investigates how innovation of ICT based services takes place within existing infrastructures, including the whole network of technology, vendors and customers. Our research question is, how can an information infrastructure provide generative mechanisms for innovation of ICT based services?

Building on a critical realist approach, our empirical evidence was a case study within an international airline, aiming to diversify its services. From our analysis we propose that there are two self-reinforcement mechanisms in information infrastructures. First, we identified the innovation reinforcement mechanism, resulting in new services. Second, there is the service reinforcement mechanism, resulting in more users and profits.

The practical implication of our framework is to show that although ICT-based innovation cannot be planned and managed in detail, the innovation mechanism may help organisations to facilitate the innovation process in a structured way.

Keywords: Innovation, information infrastructure, generative mechanism, case study

1 INTRODUCTION

During the past decade innovation of ICT based services has transformed several industries, such as financial services, telecom and IT, and media. Other sectors are following, for example the music industry and e-government. Innovation is not easy; it is hard to plan and manage (Tidd and Hull 2003), it is socio-technical and non-linear (Janszen 2000) and should be done mindfully (Swanson and Ramiller 2004). As Christensen has shown, innovation is also paradoxical; the innovative company faces the danger of becoming a victim of its own success, as it develops a mindset that hinders new innovations (Christensen 1997).

This paper explores innovation from the perspective of information infrastructures. As defined by Hanseth an information infrastructure is "a shared, evolving, open, standardized, and heterogeneous installed base*"* (Hanseth 2002*)* (p. 2). The key term in this concept is the *installed base*, which denotes the number of components and users in the information infrastructure. For example, the installed base of iPod consists of the iPod players, the central music database and the millions of users. The key attribute of a successful information infrastructure is the self-reinforcing mechanism, illustrated with Gindley's figure below. An installed base attracts complimentary products. This makes the information infrastructure more attractive to users, and generates more use, which in turn increases the size of the installed base.

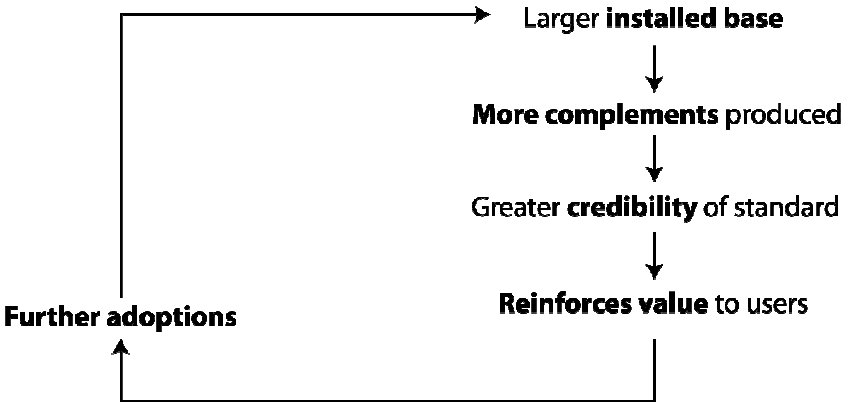

Figure 1. Grindley's standards reinforcement mechanism. (From Hanseth, 2002).

Compared to the traditional concept of information systems, the notion of information infrastructure offers two important advantages. First, it changes the object of study from a single application within a company to the world of large socio-technical networks. Second, it offers a new perspective on how such solutions are developed. While the stand-alone system can be designed and implemented, the information infrastructure is seldom designed from scratch; rather it is growing more organically from an existing base.

In the context of innovation this creates a certain paradox with information infrastructure; on one hand they are usually not made from scratch, on the other hand a number of information infrastructures are spectacular innovations. Well known examples are Internet based supply chain networks, FaceBook and eBay. This calls for more research on how successful infrastructures are developed in more detail.

This paper investigates how innovation of ICT based services takes place within existing infrastructures, including the whole network of technology, vendors and customers. One point of departure is that information infrastructures usually represent large investments in IT architecture. Thus, one ambition is to understand the self-reinforcement mechanisms in more detail, in particular the role of the IT architecture.

The research question is:

- How can an information infrastructure provide generative mechanisms for innovation?

This paper proceeds by a review of some central contributions on information infrastructure and innovation. Then, in section 3, the research approach is briefly presented, while section 4 presents the case study. Findings are discussed in section 5 and conclusions offered in section 6.

2 A BRIEF REVIEW ON INNOVATION IN INFRASTRUCTURES

Star and Ruhleder (1996) asserted that "infrastructure is a fundamentally relational concept. It becomes infrastructure in relation to organized practices" (p. 4). They defined information infrastructure in the following terms: It is *embedded* into other structures, *transparent* in use, has *reach and scope* beyond a single event, is *learned as part of a membership*, it links with *conventions of practice*, *embodies standards* to be able to plug into other structures, is built on an *installed base* and, finally, it becomes *visible upon breakdowns* (Star and Ruhleder 1996).

Thus, innovation in information infrastructures presents a double set of challenges.

First, ICT based service innovation is in itself a complex process. The service innovation process differs from the innovation of products: Services are usually developed in close interaction with the customers, and they are more often innovated in networks rather than labs. (Tidd and Hull 2003; Abramovici and Bancel-Charensol 2004). ICT based service innovation often redefines the roles of the service provider and the users. An illustrative and very successful example is the Internet bank. The real innovation of Internet banking is not the web software, but the *redefinition of roles*: The bank organization provides the technological infrastructure, the technology is available 24/7, and the customers are doing the transactions themselves. The actual innovation is the interplay between the providing organization, the new technology and the users.

Second, research on information infrastructures has shown that the development trajectories of information infrastructures are hard to predict and control (Ciborra 2000; Hanseth 2007). Extensive case research showed that many of the key approaches from strategic IT management, such as top-down planning, management control and strategic alignment, do not work as intended in the context of corporate information infrastructures. Rather, the authors assert that top-down approaches rather will increase the managerial problems of large information infrastructures, and instead they point to such concepts as *cultivation* and *care in order* to foster innovation and growth. Taking these ideas further Hanseth and Lyytinen pointed out that large-scale information infrastructures have a complexity that goes beyond traditional systems design. They proposed a full theory on the design of information infrastructures, focusing on how to foster the growth of an installed base, building on networks economics and complexity theory (Hanseth and Lyytinen 2008).

The five principles are (p.11):

- Design initially for usefulness
- Draw upon existing installed bases
- Expand installed base by persuasive tactics
- Make it simple
- Modularize by building separately key functions of each infrastructure, use layering, and gateways

These key design principles exploit the dynamics of self-reinforcing mechanisms of growing information infrastructures. In addition, we need to consider another feature of information infrastructure innovation, namely innovation as a collective process.

Fifteen years ago van de Ven described innovation as a collective process, including not only the entrepreneur, but also includes a variety of industrial and public actors (Van de Ven 1993). The insight that innovations today more seldom take place within a single organisation has triggered a strong interest in different forms of co-operative innovation processes (Bessant and Tidd 2007). Andersson et

al. found that architectural knowledge is crucial in inter-organisational innovation, in four dimensions: technology capability awareness, use context sensitivity, business model understanding and boundary-spanning competence (Andersson et al. 2008). Other researchers have investigated the innovative capabilities of distributed and heterogeneous networks, and showed that innovations in this context may be regarded as a series of cognitive and social translations (Yoo et al. 2008). Cognitive translations include the creation of ideas into actionable artifacts, while social translations take place at the borders of different knowledge communities, where involved actors negotiate and mutually adapt a solution. While the cognitive translation process is relatively linear, the social translation process is much less predictable.

Summing-up this very brief overview: We know that the innovation process in information infrastructures is complex and non-linear, that it is essential that it exploits the dynamics of self-reinforcement of the installed base and that it is a collective endeavour which is both cognitive and social. What we know less about, is the causal structure of innovation in information infrastructures, and how this is linked to the growth of the installed base. Thus, what we are looking for is a recursive structure of mechanisms, which links innovation and growth in more detail.

3 METHOD

3.1 Research approach

The general approach for this study was a critical realist case study. The basic assumption of critical realism is the existence of a real world independent of our knowledge of it. Reality is conceived as being stratified in three domains. The *real* domain consists of objects, both physical and social, with capacities for behaviour called mechanisms. These mechanisms may (or may not) trigger events in the domain of the *actual*. In the third layer these events may be (or not) observed, in the *empirical* domain. Thus, structures are not deterministic; they enable and constrain events (Archer 1995; Sayer 2000).

Critical realism combines a realist ontology with an interpretive epistemology (Sayer 2000); although a real world exists, our knowledge of it is socially constructed and fallible. This does not imply an epistemological relativism; since a real world does exist critical realism holds that some theories *approximate* reality better than others. This process of approximization is seen as a key part of scientific enquiry. It follows from this that critical realism does not aim to uncover general laws, but to understand and explain the underlying structure and mechanisms. This is done through *retroduction*; we take an empirical observation and hypothesize a mechanism that might explain that particular outcome. These mechanisms are associated with the *nature* of the object of study, not to the regularities of events (Sayer 2000).

Our object of study is an information infrastructure. Following DeLanda we envisage an information infrastructure as an *assemblage,* i.e."wholes characterized by relations of exteriorities" (p.10). The basic attributes of assemblages are (DeLanda 2006):

- An assemblage consists of various types of components, which in themselves may be assemblages. An assemblage allows for interactions between components that are emergent, i.e. mechanisms whose behaviour cannot be explained by the properties of the component.
- A component is self-subsistent and may be unplugged from one assemblage and plugged into another without losing its identity.
- A given component may play a mixture of material and expressive roles by exercising different sets of capabilities. Assemblages may increase their homogeneity by sharpening its boundaries (*territorialization*) or destabilizing it (*deterritorialization*).

In an information infrastructure context we should conceive these structures as semi-stable. They are the result of relatively stable patterns of behaviour over time, but at the same time they are changing

continuously, as the result of growth and change. For example, the behaviour of a user community will have some stable patterns (in spite of people joining or quitting), but it may also change its patterns of behaviour in interaction with a new service, at the higher level of assemblage.

3.2 Data collection

The case company, Norwegian, was chosen for two reasons. First, it was a young and successful company, with a reputation for innovation. Second, the company was expanding its initial successful infrastructure of booking services into new ICT-based services, thus constituting a fruitful case to study innovation in infrastructures.

Data collection at Norwegian was conducted during a period of six months in 2008. Ten managers and specialists were interviewed, each circa 2 hours, some of them twice. In addition a large volume of technical documentation (business plans, project plans, contracts, technical architecture documents) was analysed. To ensure internal validity the preliminary findings were discussed with informants, and paper drafts were sent key informants for comments.

3.3 Data analysis

The inspiration for the data analysis was the following passage from de Landa (2006):

> "To give a complete explanation of a social process at a given scale, we need to elucidate not only micro-macro mechanisms, those behind the emergence of the whole, but also the macro-micro mechanisms through which the whole provides its component parts with constraints and resources, placing limitations on what they can do while enabling novel performances" (p.34).

The practical search for these mechanisms was conducted in the following three steps (Pettigrew 1985). First, a time line was established, and important events were identified. Then a comprehensive analysis of organizational design and culture, technical development and business strategies was done, focusing particularly on the interplay between these dimensions. Third, to ensure internal validity the preliminary findings were discussed with informants, and paper drafts were sent to key informants for comments.

4 THE CASE STUDY

Norwegian is an international airline carrier based in Norway. Its strong growth started in 2002, when it established a national network, helped by the government deregulation of the airline industry. Today the company has 1.300 employees, 85 destinations in Europe and carried 9.1 mill passengers in 2008. More than 85 % of ticket sales are accomplished on the web (Norwegian.no). The company has pioneered the Scandinavian low price airline market, and has been quite innovative. Some important events were:

2002 : Introducing low cost airline in Norway, with print-out tickets with bar-code identification

2004 : Introducing the low-price calendar (this was internationally patented)

2005 : Dialogue with 85% of customers is electronic

2007 : Bank Norwegian is introduced

2008 : Call Norwegian (mobile telephone operator) is introduced

In 2007 the company decided to enter the banking market with Bank Norwegian. Said the CEO Bjørn Kjos at the start: "Today we have one of the most visited web pages in Norway, with 2-3 million visitors each month. We aim at coupling this traffic towards bank services." (E24, 4th May 2007). The initiative has been quite successful; in fact so successful that Norwegian will offer a mobile service Call Norwegian, based on the same thinking.

If we look closer at the company parts of the success may be explained by a particular IT architecture. It is illustrated and simplified in figure 2. The key elements are the web page for each service, the databases and "the bus." Each service constitutes an information infrastructure, with a number of registered customers. For the airline this is currently ca. 1 million, for the bank around 80.000, while the mobile company was starting up in the autumn 2008. In this paper the focus is on the development of Call Norwegian, as an extension to the established infrastructure.

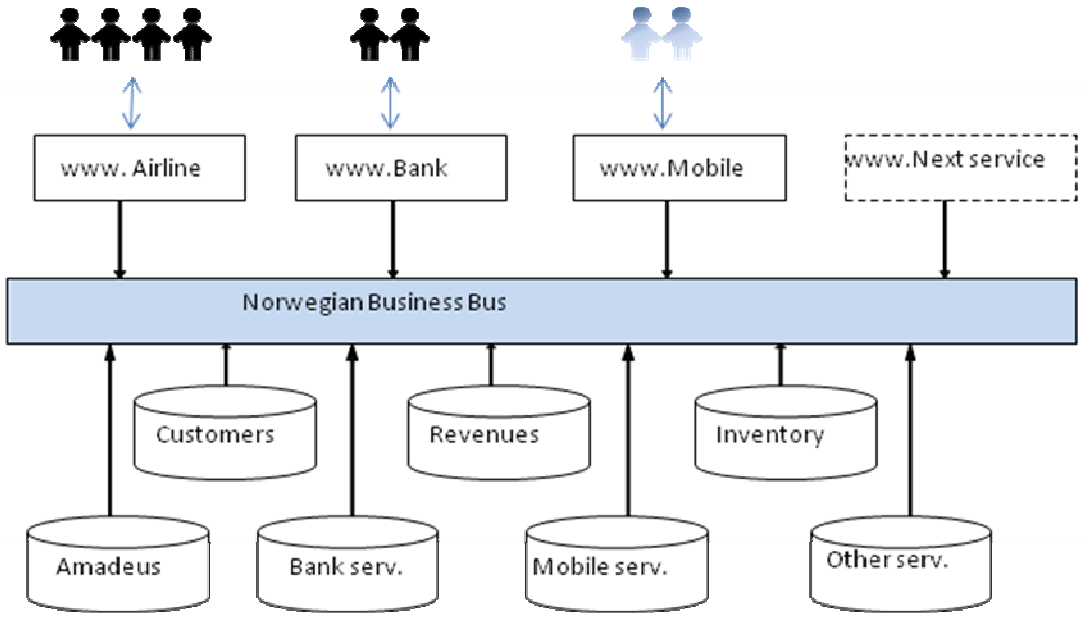

Figure 2: Infrastructure at Norwegian

The architecture allows the company to innovate on an existing infrastructure, in much the same way as Virgin and Amazon (Cai et al. 2008) have done. The traffic on the airline website may be routed to other services at very low marketing costs. Accordingly, extended infrastructure services, such as bank system and mobile system (from external providers) may be linked to the "bus" at low costs and in time windows of opportunity. It is essential that all communication with the customers is electronic, as a combination of web pages and e-mail. Of course, this lowers transaction costs, but more importantly, it makes it much easier to enroll new customers into the infrastructure.

4.1 Call Norwegian

The idea of a mobile company came in 2005, after the initial success of Norwegian. Where do ideas come from?

Said the Director of business development:

> "We had established a very flexible IT architecture, and we realized at the time that it would be possible to innovate new services on this. First we were just brainstorming rather freely; how could a combination of brand and technology generate new business? A GSM operator seemed to have some similarities with airline booking. Later, after the establishment of Bank Norwegian and the reward system in 2007, the idea had matured. We now focused much more on achieving synergies with the airline by providing an integrated set of mobile services for the traveler. We believe that the mobile phone will become more important as a terminal than the PC"

After a board decision in January 2008 a project was established. The main ambition of the project was to establish a number of mobile services:

- A mobile portal, with booking, payment and check-in services, plus content from many providers
- Broadband mobile access at airports and during flights
- GSM mobile services

In March a detailed Request for Information was sent to various telecom vendors, and a series of meetings were held in April. The business model was completed in May, and the contracts with the key vendors signed in August. The project was then organised with 5 sub-projects, illustrated in table 2. Norwegian organised the project as close as possible to the future operations. The project was run by Norwegian Portal Director, acting as CIO in Call, using hired expert consultants in the planning and development phase.

Sub project	**Technology**	**Responsible in operational phase**
Mobile portal	Norwegian solution developed in .NET	Norwegian and partners' services
Airport services	Norwegian solution developed in .NET based on Radius Server and infrastructure provided by Call Norwegian and Avinor	Avinor
Billing	NaviBilling by TeleBilling	TeleBilling
Network on board	Not yet decided	Norwegian and partner
Budget and finance		Norwegian

Table 2: The Call Norwegian project

The Director of Business Development commented:

> "When we started the project the solutions were only sketched out as architectural ideas and financial opportunities. We learned a lot from the meetings with potential vendors and content providers in the spring 2008, exploring a space of possibilities."

Said the Portal Director:

> We focused on how to make money on new services, analysing which services we should provide ourselves, which we should buy and how they should be integrated. At the same time we are very concerned about our architecture; it as an important ambition to maintain it as 'clean' as possible. We don't really go for cutting-edge solutions. Rather, we combine known and stabile components in new ways."

The technical solution is illustrated in figure 3. The central element is the Call Norwegian Business Bus and interfaces, and all communication goes via the bus, as web services. This also includes communication with the Airline bus (CRM base) and the Norwegian Bank Bus (reward services). Most new services were bought, but a few was developed in-house, such as the purchasing and handling of wireless access at the airports.

The bus serves as a backbone for the various transaction systems such as billing, finance, GSM services, and Norwegian's shared CRM system. It also connects these systems to the sales and service channels, in particular mobile, web and email communications. Technically, the bus is a piece of .net software. It enables the company to expand the number of sales nodes (above) and the service nodes (below). In technical terms we might describe the function of the bus as bridging two different standards; the standards of World Wide Web with the standards of telecom and billing systems. This service oriented architecture allows the company to establish new nodes, and get rid of unneeded ones, in a very short time span, because the services are bought or leased, not developed.

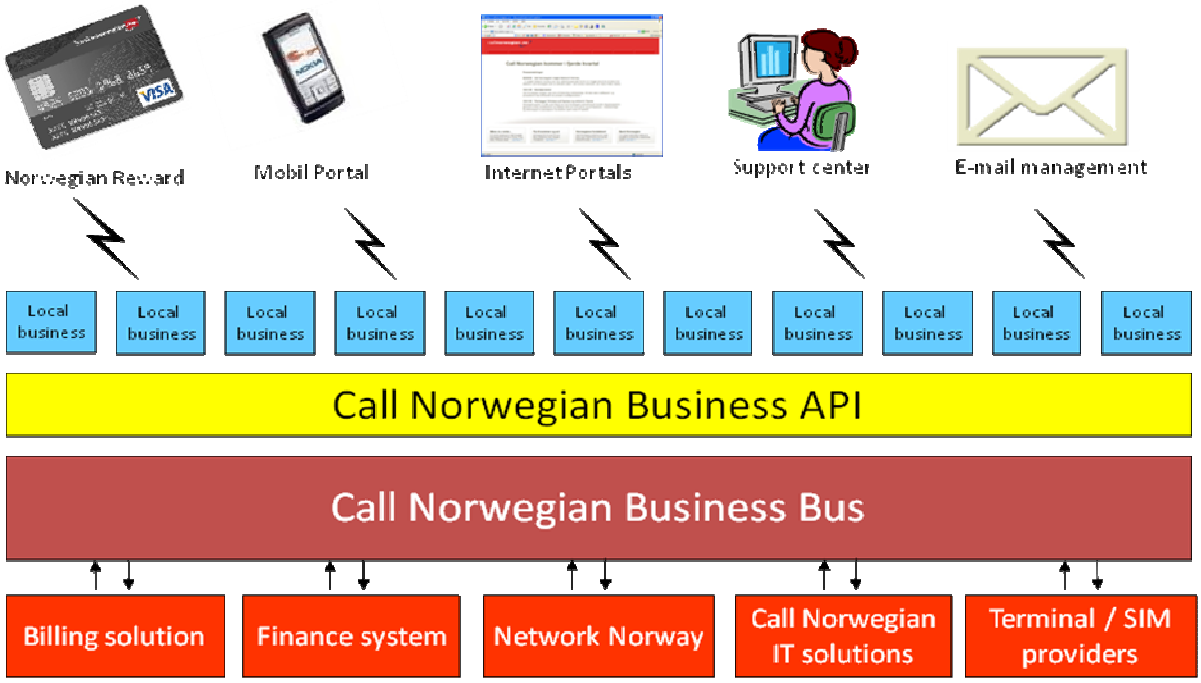

Figure 3: Call Norwegian infrastructure (Courtesy of H.-P. Aanby)

Seen as information infrastructure we may describe it as a heterogeneous network, consisting of a large number of actors, connected to the business bus.

- Users will access the services via the mobile portal. One minor (but exciting) innovation is using the mobile phone to check-in and boarding, by providing a link to a ticket barcode, which may be read electronically right from the mobile screen.
- The providers of services include TeleBilling, who provided billing, Avinor who provided airport broadband, Network Norway, who provided GSM services, and Norwegian, who provided travel and profile services.
- A large number of content providers, who will provide news and travel information. A potential new service is location and context based information to travelers.

The complexity of integrating these very specialized services may appear large, but the bus structure and web services simplify the technical solutions. More interesting, in the context of information infrastructure innovation, which socio-technical mechanisms are active in the extending this infrastructure?

5 MECHANISMS FOR INNOVATING IN THE INFRASTRUCTURE

5.1 Returning to the research question: How can an information infrastructure provide generative mechanisms for innovation?

Following DeLanda's call of investigation of both macro-micro and micro-macro mechanism; what we are looking for is a recursive structure of mechanisms. This structure should explain how the information infrastructure is generating innovation, and also how the innovations are modifying the information infrastructure. Further, these mechanisms should be "external", in the sense that their capabilities are not decided from the components' internal properties. For example, an IT architecture may have certain properties, such as being layered. This property is quite important, but it is not a mechanism. A mechanism emerges from the relationship between the IT architecture and some other

component, where the IT architecture plays *a role* in a larger context. For example, the IT architecture may allow someone to produce a new service. This does not (in itself) change the layer structure of the IT architecture, rather its ability to play different roles in different settings is more related to its interfaces.

5.2 Macro-micro mechanism

Several of the interviewees used the expression of *space of possibilities*, as the starting point for innovation. What constitutes this space? The respondents gave different answers. Some emphasized the business opportunity by logic of analogy; that a successful service (such as airline booking) is *similar* to the business of a mobile operator. Another informant pointed to the modularization and layers of the IT architecture, while a third informant emphasized the role of external partners in idea generation.

When examined more closely, the space of possibilities more fundamentally has to do with patterns of assembling different components into new services. The point is that these new services emerge through new combinations of components in way that generate a self reinforcing mechanism. This mechanism was also identified (although at a business level, not service level) by (Davenport and Short 1990).

We may illustrate this process in figure 4.

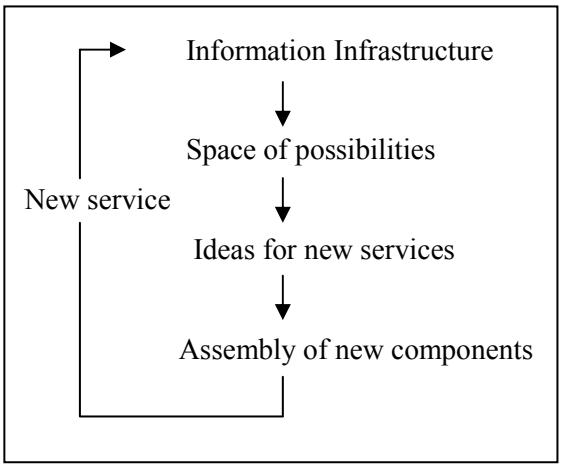

Figure 4. The innovation reinforcement mechanism

The established information infrastructure (of Airline and Bank) offered a space of possibilities, constituted of the following elements:

- A large user group (ca 1 mill individual customers), represented in the central CRM system
- An IT architecture, where components may be reused
- A (limited) number of key persons with a thorough knowledge of the dynamics of the information infrastructure, including a strong technical knowledge of the IT architecture.

The next step was to combine these elements into ideas, and from there to assemble the components into new services. More than 30 different companies from telecom and IT were involved in these talks. The Portal Director described the process in these terms:

> "Based on the overall architecture we decided which components to build, reuse, buy or outsource. We involved various actors, such as IT, Sales, Marketing, expert consultants and

external vendors. Contracts with vendors were signed and integration specifications made. The design and development process was iterative, producing design sketches, arranging workshops, evaluating new builds, optimizing and testing."

In this description we recognize the findings of Andersson et al. (2008), that inter-organisational innovation requires a demanding set of architectural knowledge. For example, the operator of the billing services had to a) understand the inner workings of both Norwegian's corporate bus architecture and the Telebilling system and b) be able to implement a solution which connects these two resources.

5.3 Micro-macro mechanism

At the end of this process, illustrated with the upward arrow, we find the micro-macro mechanism. As the information infrastructure has generated a new service, this will extend the information infrastructure. Technically, this will in the form of a new bus with web service interfaces, a set of new databases and a new set of terminal devices. The information infrastructure will further include the vendors and operations, and the thousands of new customers.

The extended information infrastructure will increase the space of possibilities. To get the full picture we may extend the figure with another feedback loop, the self-reinforcing mechanism of services.

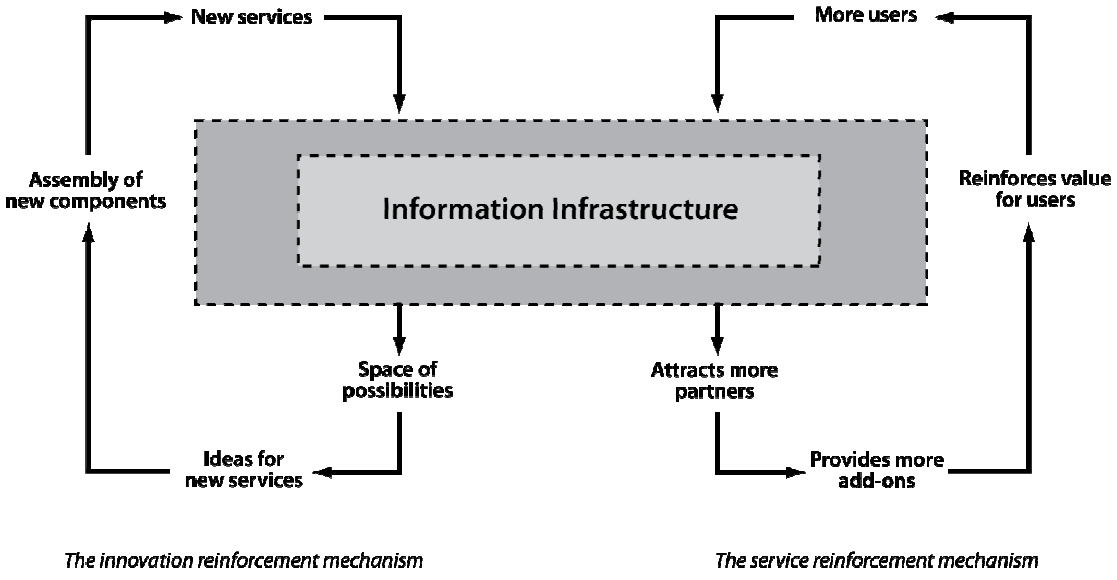

Figure 5: The double set of self-reinforcing mechanisms of information infrastructures

As illustrated in figure 5 the information infrastructure has two self-reinforcing mechanisms. First, there is the innovation reinforcement mechanism, which was described above. At macro (infrastructure) level the result of the mechanism is a new service which extends the information infrastructure. The Second mechanism is the service reinforcement mechanism, which is built on Grindle's standard's model, described in the Introduction. The result of this mechanism is more users to the information infrastructure.

The result is also a financial profit, which may be used to invest in more innovation. This closes the double loop. The innovation loop provides new services in the information infrastructure, which in turn (in the service loop) creates more profits. And so on.

5.4 Implications

The practical implications of self-reinforcing service mechanism have been described by other researchers, in the form of guidelines for information infrastructure design (Hanseth and Lyytinen 2008). The practical implications of the self-reinforcing innovation mechanism are more elusive, but two suggestions may serve as an inspiration for further research.

First, a successful information infrastructure constitutes a considerable resource for ICT-based service innovation. The innovation mechanism and the Call Norwegian case, illustrate how these resources may be assembled into new innovations. One should however not interpret this as a friction-free process, because the whole information infrastructure may be set under pressure as it expands, both in terms of IT architectural and social complexity. Using DeLanda's (2006) terms, we might characterize it as a struggle between territorialisation (increased homogeneity) and deterritorialisation (destabilising).

Second, as described by Yoo et al. the innovation process in networks is both cognitive, social and non-linear (Yoo et al. 2008). In line with other information infrastructure research our findings illustrates that ICT-based service innovation cannot be planned and managed in detail. But the innovation mechanism may help organisations to facilitate the innovation process in a structured way.

6 CONCLUSION

This paper investigated innovation in information infrastructures, through a case study. Building on a critical realist approach, our empirical evidence was a case study within an international airline, aiming to diversify its services. From our analysis we propose that there are two self-reinforcement mechanisms in information infrastructures.

First, we identified the innovation reinforcement mechanism, resulting in a new service. This consists of the following steps: A space of possibilities in the information infrastructure architecture and operations creates new ideas for services. Together with external partners these may be developed into innovations, which will be included in the information infrastructure as new services. The new services and components in turn increase the space of possibilities.

Second, there is the service reinforcement mechanism, resulting in more users and profits. The information infrastructure provides a number of cheap and easy-to-use services. This attracts more partners with their add-on services, which reinforces the value of the information infrastructure, and attracts more users. This growth generates a profit which may be used to invest in new innovations.

The proposed mechanisms were derived from the information infrastructure literature and the case study. Further research should look at innovation in other information infrastructures, both to test the validity of the suggested mechanisms and to discover others.

7 ACKNOWLEDGEMENTS

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