Inf Syst Front
DOI 10.1007/s10796-009-9169-9

ICT infrastructure for innovation: A case study of the enterprise service bus approach

Bendik Bygstad · Hans-Petter Aanby

Abstract In this paper we investigate the relationship between ICT infrastructure and innovation. In recent years the concept of the *enterprise service bus* has been introduced as an ICT architecture that supports strong integration of distributed components and services, but at the same time allows for adding or subtracting business partners at short notice. What are the organizational issues and challenges of this approach? Building on a case study from Norway we investigated this topic in the context of innovation of ICT based services. Our findings were analyzed at three levels; the bus as technical infrastructure, the bus as innovation infrastructure and the bus as organizational structure. We find that the bus as technical infrastructure supports innovation within a business unit, while the bus as innovation infrastructure facilitates the innovation of new business services. Further, we propose that a shared topology of these three levels is important to support the overall innovation process. As illustrated in our case, this also raises new challenges for the innovative corporation.

Keywords Innovation · ICT infrastructure · Enterprise service bus · Case study

B. Bygstad (✉)
Norwegian School of IT,
Schweigaards gt.14,
0185 Oslo, Norway
e-mail: Bendik.bygstad@nith.no

H.-P. Aanby
Norwegian ASA,
Oksenøyv. 10 A,
1366 Lysaker, Norway
e-mail: hans-petter.aanby@norwegian.no

1 Introduction

Innovation of new ICT (information and communication technology) based services has become one of the most important arenas for global competition, with outstanding examples in many industries, such as search engines (Google), auctions (eBay), gaming (World of Warcraft), music (iPod) and travel services (Hotels.com). Our point of departure is that such innovations are seldom created out of air; they need an infrastructure to innovate on. A fascinating example is the success of Google. As documented by Iyer and Davenport Google's innovation strategy depends heavily on their infrastructure. Google is "built to build", with a scalable infrastructure which enables an accelerated product development cycle, with support for third party development (Iyer and Davenport 2008).

Such infrastructures are large networks (or "assemblages") of technical and business components (Ciborra 2000; Hanseth and Lyytinen 2008). For a successful corporation an effective infrastructure is an immense resource; it constitutes the backbone of the organization. On the other hand, there is a tension between infrastructure and innovation: the business forces urge rapid innovation, while the infrastructure supports incremental change.

In 2002 the notion of *Enterprise Service Bus* (ESB) was introduced (Chappell 2004). The Enterprise Service Bus is an ICT architecture that aims at being able to support two seemingly contradictory features: It integrates a network of business partners at a transactional level, enabling real-time systems to communicate seamlessly. At the same time the components are loosely coupled; it is possible to add or subtract business partners at short notice, without affecting the daily running of operations. In principle, this is indeed an infrastructure to support service innovation.

Published online: 06 May 2009

The bus architecture is an attractive idea, which has received much attention the past few years. However, the ESB concept is primarily a technical architecture, and many issues remain much less known. In particular, the more direct relationship between ICT infrastructure, innovative capability and organizational form is not described in the ESB literature. How should a company organize this in practice? Which organizational mechanisms are at work in the process? In this research we investigate these issues through a case study. Extending the purely technical perspective, we analyze our findings on three levels:

1. The service bus as technical infrastructure
2. The service bus as innovation infrastructure
3. The service bus as organizational structure

Our approach is theoretically informed, but our aim is rather practical: we wish to contribute to understand and manage the innovation of ICT based services in an infrastructure context. The paper proceeds by reviewing earlier relevant research, particularly the enterprise service bus concept and the theory of modular organizations. Then we present the case company (Norwegian Corp.) and our research approach. We analyze our findings in detail and discuss their possible implications. Lastly, we offer conclusions and suggest further research.

2 Review

The relationship between organizational forms and ICT has been studied extensively the past two decades (Beniger 1986; Fulk and DeSanctis 1999) and researchers have suggested terms such as *network* organization (Fulk and DeSanctis 1999), *virtual* organization (Markus et al. 2000) and *horizontal* organization (Castells 1996). Beniger (1986) viewed technology and organizational form as *homologous*, viewing the design of technology and organization as an integrated task. Fulk and DeSanctis (1999) showed that there is a causal and reciprocal relationship between ICT and new organizational forms, in four dimensions:

- Changes in size, scope and products: A trend toward flexible specialization and information intensive products
- Vertical control: Flatter organizations, reduced middle management
- Horizontal control: Electronic workflow, concurrent engineering and cross-functional teams
- Changes in connections: Networks and strategic alliances.

In general terms it seems reasonable to conclude that, although there are large variations, these features have become prominent in many modern organizations during the past decade. The main driver for this development has hardly been an urge for organizational innovations but rather a cut-throat competition in a global marketplace. This has been particularly true for the service sector, for which the Internet has made a dramatic impact (Tidd and Hull 2003).

In understanding the service sector companies' responses to these challenges, we think it is useful to draw on the concept of *enterprise service bus* and the theory of modular organizations.

2.1 The enterprise service bus

In the early 1990s the ICT architecture of most companies was not much more than a collection of applications. In response to the notorious problems of integration various frameworks have been proposed the past decade, such as *enterprise architecture* (Ross et al. 2006), which is a holistic and comprehensive approach to the organization's IT resources, and *enterprise application integration* (Cummins 2002), a more application oriented approach. In recent years the concept of service oriented architecture (SOA) has become prominent. SOA is a general framework that views the basic building blocks of an IT architecture, not as systems or modules, but as services. These services are made available through standardized interfaces and messaging (Marks and Bell 2006; Zhao et al. 2007).

The enterprise service bus may be regarded as an implementation of SOA. The key attributes of ESB are (Chappell 2004):

- A distributed service architecture that facilitates messaging (using web services and XML) between different applications and services
- A management infrastructure that enables configuring, deploying and monitoring the remote services

This allows for full integration between both internal and external services at transactional level. At the same time the coupling of these services is loose, enabling the company to change business partners at relatively short notice. An important feature of ESB is a flexible approach to standards, in the sense that business units can develop solutions in their chosen technical environments, as long as they comply with the interface/messaging standards.

2.2 Modular organizations

The idea of solving complex problems by modularizing was described formally by Parnas in his classical paper on decomposing systems into modules (Parnas 1972). The key point is that of *information hiding*, i.e. one should strive to minimize dependencies between modules. The way to do this is by hiding the complexity of the inner workings inside the module, and only allow for communication through simple and well defined interfaces.

This principle became a cornerstone of object oriented programming, but it has also become an important part of the research on organizational innovation the past 15 years. Researchers have documented that today's rapid change and systemic technologies means that no single company can successfully innovate and produce all components (Garud and Kumaraswamy 1995). In their much cited work and Baldwin and Clark (1997) has claimed that the complexity of modern technology has led to the emergence of modular (and networked) organizations. Baldwin and Clark proposed that modularity of both technology and organizations will trigger an unprecedented growth of innovations in the service industries. There are two main drivers for this. First, the modularization of components allows for an almost infinite number of combinations of elements, which will open for completely new types of services. Second, the modularization of firm will increase the capabilities of components, because of specialization and economies of scale. It is also noteworthy that the proposed design rules of Baldwin and Clark (p.86) are quite consistent with the principles of the enterprise service bus architecture, as described by Chappell (2004).

To a skeptical IS reader this may sound too good to be true. There are certainly limitations to this vision of a frictionless arena of innovation. A basic insight from sociology is the trade-off between integration and differentiation. In their classical article Lawrence and Lorsch showed that organizations differentiate in response to environmental challenges, such as competition and demand. Differentiation allows for specialization and task focus, thus increasing efficiency. The more we differentiate, however, the more complex becomes coordination (Lawrence and Lorsch 1967). Indeed, Schilling has shown that a number of issues arise from this increasing complexity of components and firms (Schilling 2000).

Both the enterprise service bus concept and the theory of modular organizations are rather general concepts, and we believe that the diversity of firms and contexts is too great to expect overall regularities. The aim of this paper is therefore to discuss these issues in a more limited context, through an in-depth case study of the implementation and use of business bus architectures.

3 Research approach

In this section we first present our case company, and then our research method. The case company, Norwegian, was chosen for two reasons. First, it is a young and successful company, with a reputation for innovation. Second, the company was expanding their initial successful infrastructure of booking services into new ICT-based services, thus constituting a fruitful case to study innovation in business bus infrastructures.

3.1 The case: Norwegian corp

Norwegian Corp is a privately owned company registered on the Oslo stock exchange. Led by the charismatic former jet fighter pilot Bjørn Kjos, the *Norwegian* airline company grew from virtually zero in 2002 to become the largest low-cost carrier in Scandinavia in 2008 (Fig. 1 shows the current route map of Norwegian). Today Norwegian operates a total of 176 routes to 86 destinations in Europe, and carried 9.1 million passengers in 2008. The company has 1,400 employees and revenues in 2008 were 6.2 bn. NOK ($ 900 M.) Profits, however, have been moderate.

For a start-up low-cost air carrier a major challenge in 2002 was to reduce the cost of sales, by transferring the booking of tickets from agents to passengers. This was done in 2003, by a well designed web portal and the introduction of print-out tickets, which enabled the passengers to print their own tickets during the web based booking process. The bar-code was read electronically at the gate, as the only check-in point. This eliminated the need for travel agents, and the web portal was gradually refined to enable an increase in Internet booking from 30% of the total in 2003 to 50% in 2004 and 85% in 2005. This quite fast transformation was also enabled by the customer data base, which was used both for online booking and customer communication on email.

A major obstacle for low-price passengers at the time was how to find the cheap tickets, which used to be hidden inside a complex pricing structure. Capitalizing on their new ICT architecture (described below) Norwegian solved this nuisance in 2004 when the low-price calendar was introduced, which showed the cheapest flights to any chosen destination. This was on outstanding success, increasing the number of bookings substantially. The low-price calendar was internationally patented, although later copied by many other airlines.

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 was quite successful, and Norwegian in 2008 launched a mobile service Call Norwegian, based on the same thinking.

3.2 Research method

We conducted an in-depth case study (Miles and Huberman 1994), focusing on the relationship between infrastructure and innovation. The general approach was process-oriented (Langley 1999); taking a longitudinal view we were looking for explanations of events. Data collection was conducted during a period of ten months in 2008 and 2009. Ten managers and specialist were interviewed, each circa

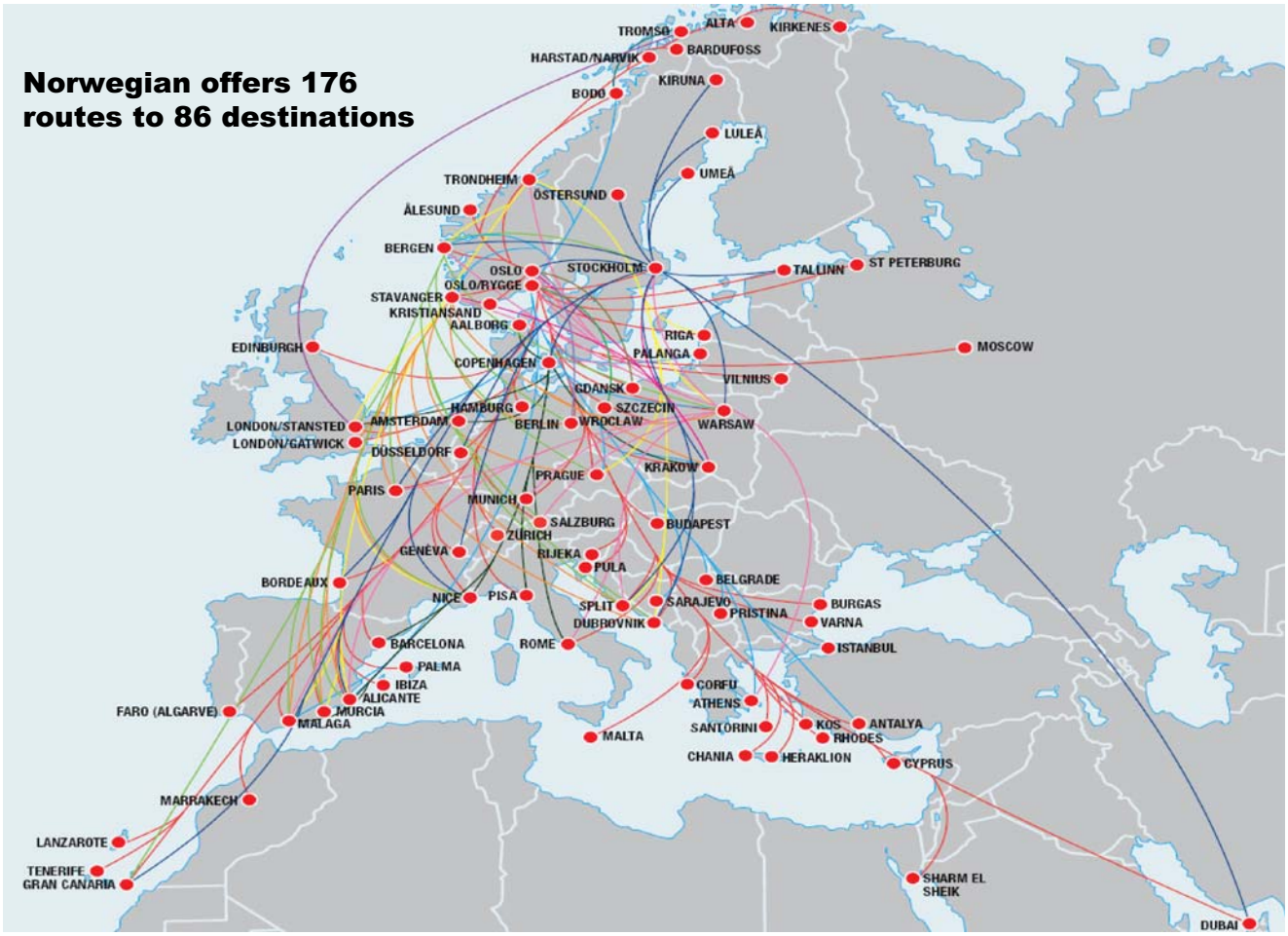

Fig. 1 Norwegian's routes

2 h, some of them twice. In addition a large volume of technical documentation (business plans, project plans, contracts, technical architecture documents) was collected.

Data analysis 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 Case findings

In this section we present and discuss our findings. They are summarized in Table 1.

4.1 Level 1: The bus as technical infrastructure

Norwegian's founder was an aircraft enthusiast, with little interest for the complexities of information systems, which was considered an overhead. This changed in 2002 when increasing booking volumes led to the hiring of a CIO. In 2003 an IT strategy was crafted and implemented. The IT management team was mainly recruited from Norwegian's main competitor in Scandinavia, and the IT strategy was a combination of business strategy and IT infrastructure. The architecture is illustrated in Fig. 2.

The key element is the *Norwegian Business Bus*, which has two distinct features: First, it serves as a backbone for the various transaction systems such as passenger booking, CRM and pricing and scheduling systems. Second, it connects these systems to the sales channels, in particular web and email communications, but also travel agents and retailers. Technically, the bus is a piece of open source Java

Table 1 Three levels of bus architecture

Level	Description	Innovation aspect
Level 1: Technical infrastructure	A service bus architecture, based on an opensource bus with web service interfaces.	Enables the extension of new components at low cost, within a business unit.
Level 2: Service innovation infrastructure	An innovation mechanism, based on combinations of resources on the bus.	Enables the innovation of new business services.
Level 3: Organizational structure	A lean and flat organization structure, structured on business units.	Enables creative cooperation and fast decisions.

software, with web service interfaces. 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 international booking (Amadeus) and banking systems. This service bus 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. The only in-house developed software is the interfaces of the bus.

4.2 Level 2: The bus as service innovation infrastructure

The architecture allows the company to innovate on an existing infrastructure, in much the same way as Virgin and Amazon have done (Cai et al. 2008). The bus works as a generative innovation mechanism, in the sense that it enables and support the development of new services. In broad terms this is performed by adding, or removing, sales nodes or service nodes connected to the bus.

A new large-scale service was introduced in 2007, when the Bank Norwegian was launched. Said the CEO Bjørn Kjos at the start: "Today we have one of the most visited web pages in Norway, with 2–3 million unique visitors each month. We aim at coupling this traffic towards banking services." The initiative has been quite successful; after 6 months of operation the bank had 50.000 customers. A central feature is that the bank systems are outsourced (and plugged into the bus) and the communication with customers is fully electronic, including credit checks. This means that the whole banking operation is handled by an amazing 30 people.

Figure 3 illustrates conceptually the bus innovation structure. The upper layer shows the new services, which are connected to the transaction systems in the lower layer—connected to the bus. At this level, the bus topology should not be taken as a physical artifact, but rather as an innovation mechanism that interacts with the underlying infrastructure. At the upper level the next innovation is illustrated; in the autumn 2008 the *Call Norwegian* mobile phone company was launched. It is based on the same

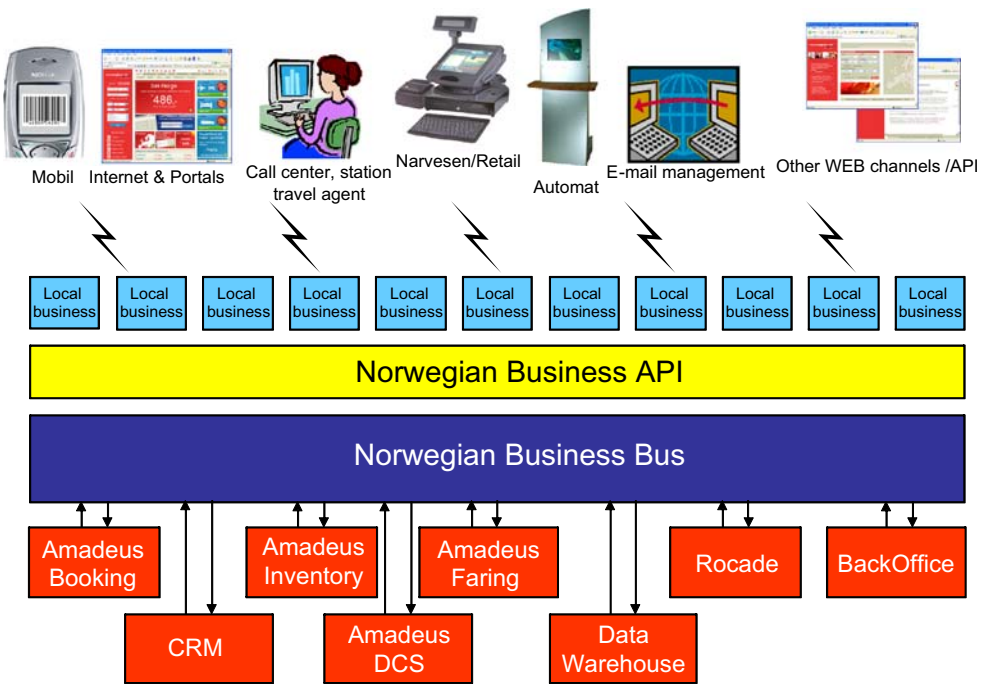

Fig. 2 Technical infrastructure of airline company

thinking, connecting possible customers from the web site of airline and banking to new resources (mobile services) on the bus. As indicated on the upper right in the figure, this innovation process will continue.

4.3 Level 3: The bus as organization structure

The two levels described so far may give the misleading impression that we argue that innovation is a function of business architecture. On the contrary; innovation is done by people, also at Norwegian. No longer a small start-up company, the organization has experimented with its structure during the years of fast innovation and growth. The result is the *organization bus*, as illustrated in Fig. 4.

Figure 4 is not the formal organization chart of Norwegian, but it illustrates the organizational thinking of the company. At this level the bus should be understood as an arena for human communication. The bus topology allows ideas to flow inside the organization, because a call may come from any unit. Thus, each unit becomes a resource to accomplish something, not a chain of command.

First, there is no clear hierarchy Of course, the CEO is the boss, but he is still only a node on the bus. His main task is to ensure the recruitment of the right people (the nodes) and to schedule the flow and priorities of initiatives. Initiatives may come from any employee in Norwegian, who are frequent contributors to an idea database currently including 1,200 proposals.

Employees are empowered to a large degree, with clear business accountabilities. A middle manager in the Revenue department commented: "As long as I reach the company objectives I am free to choose my actions. This includes the right to propose and implement changes in the computer systems. Of course, this does not mean that Norwegian is a flat organization, but it gives you the feeling that it is. The reason is that a good idea is never rejected for hierarchical reasons."

Second, there are no "IT projects", only business projects New ideas come along the organization bus as business proposals, often in the form of a proposal entered into the idea database. They are evaluated on the sole criterion of financial benefits. If approved the involved units will co-operate to accomplish the necessary work, small changes in an informal group; larger initiatives in formal projects. This way, the people who build a solution will also operate it. A characteristic feature is that these initiatives are seldom completed; they are run only until the financial benefits are reaped. "Although the IT specialists dislike this, at that point in time there will be a new initiative that gets a higher priority" said the sales director.

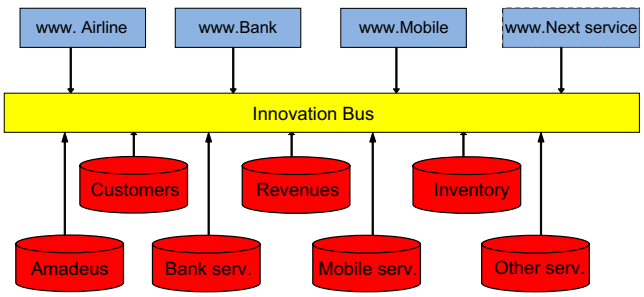

Fig. 3 The innovation infrastructure

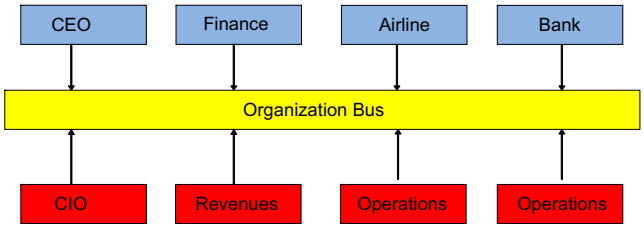

Fig. 4 The organization bus

Third, there is a strong entrepreneur culture The respondents of the case study were all asked to characterize the culture, and were quite unanimous in their views. There is still a strong entrepreneur culture, with innovation in small teams, flat organization, empowered employees and a strong determination to succeed. For example, the marketing director of the bank remarked: "You know, banking people are normally rather conservative and cautious. It would have been next to impossible to establish a new bank within six months in a banking culture. The only way we could succeed was by adopting the culture from the Airline, including the very business oriented IT people".

We should admit that although these features facilitate innovation, they also generate stress. Not everybody will thrive in such environments, and we will discuss the sustainability of this culture below. As one middle manager sighed, "we are running at top speed all the time. Sometimes I wish that we worked more systematically".

5 Discussion: Learning from Norwegian

Summarized, we may describe the configuration of Norwegian as a three-level structure. This is not an organizational hierarchy, but a multilayered socio-technical structure. Level 1, the technical infrastructure, was designed in accordance with the main principles of the enterprise service bus (Chappell 2004). The innovation structure of level 2 draws on the principles of the modular organization (Baldwin and Clark 1997), and is also consistent with the innovation mechanisms at Google (Iyer and Davenport

2008) and Virgin (Cai et al. 2008). And the simplicity of level 3, the organization, may be regarded as an illustrating example of how ICT enables the flat and networked organization (Fulk and DeSanctis 1999).

What distinguishes Norwegian from other similar initiatives is the consistency of the approach and the dynamic interplay between the three levels. These levels are mutually dependent of each other, in the sense that the innovation infrastructure (level 2) is dependent both on the technical infrastructure and the organization structure to operate. The significance of the shared topology at different levels is that is reduces complexity; it makes it obvious where an opportunity should be exploited or a problem to be solved.

A recent initiative in Norwegian may illustrate this point. To increase customer value of flying with Norwegian, the company in November 2008 included free wireless broadband at some key airports. The Airline company did not develop this service, but bought it from the Call Norwegian company. Technically, this was done by a web service transaction on the corporate bus, which is executed at the very moment the customer books his ticket. Thus, the innovation of a new service was initiated at the top company bus (level 3), developed as a service (at level 2), and implemented technically at level 1. The common topology made it obvious how (and where) it should be done. It is, however, noteworthy that this "tidiness" in architecture was not reflected in the innovation *process*, which was iterative and experimental. As noted by Langlois, the inputs to a successful innovation are basically uncertain, and the principle of modularization should not be applied to the development process (Langlois 2002).

It is important to realize that the three-level structure was not the result of a strategic and analytical process, but rather a response to the intense competitive pressures of the airline industry. While it might be risky to copy such structures there may be important elements to learn for other companies. The first is that the enterprise service bus at level 1 facilitates innovation within a business unit. This may done by expanding the number of sales nodes, or by new combinations of services. The second is that the bus may facilitate innovation of new businesses, as Norwegian did with banking and telecom. This was accomplished by combining internal resources (such as customer data bases, web portals) with external services (such as banking systems or mobile services). In order to innovate new ICT based services it is essential to have a long-term view on infrastructure. A well thought-out infrastructure enables and inspires innovation, provided that there is an innovation process that understands and interacts with the infrastructure.

At the organizational level we found that Norwegian aligned its organizational design with the technical infrastructure. It is well documented that the industrially oriented corporation of the 20th century is too compartmentalized and too rigid to support the flexible and opportunity oriented innovation described in this paper (Fulk and DeSanctis 1999). The bus structure—at three levels—is one possible approach to solve this challenge.

What are the challenges of this structure? Is it sustainable? As illustrated in Table 2 a major concern at all levels is associated to further growth and to the dependence of key personnel.

At the technical level an increased number of customer services and transaction systems may create an overload for the bus to handle. Mature companies often struggle with a portfolio of large legacy systems, which are crucial for daily operations, but hamper the agility of the company. Can Norwegian keep its infrastructure clean and simple over time?

The answer is, probably not, because new generations of technology and new partner solutions will gradually increase complexity to a point where agility will suffer. The strategy chosen, however, illustrated in Fig. 5, shows how the bus architecture is realized at a corporate level. Each business area has its own bus structure, while a corporate bus (The Group Norwegian Business Bus)

Table 2 Benefits and concerns

Level	Benefits	Concerns
Level 3: The bus as organization structure	• Supports an agile and innovative organization. • Low costs	• May not be sustainable as organization grows into an international diversified company • Dependent on a culture of trust, vulnerable to power games
Level 2: The bus as service innovation infrastructure	• Enables innovation in horizontal expansion, with short time to market • Supports reuse of business components	• Synergies may be harder to harvest with further growth • Dependent on managers who understands the three level structure
Level 1: The bus as technical infrastructure	• Supports a flexible systems architecture • Enables fast extensions of services at low cost	• Increased technical complexity may threaten flexibility • Depending on key personnel with deep knowledge of architecture

handles shared transactions. In this way, the simple overall structure may be maintained over some time, although not indefinitely.

At the service innovation infrastructure level horizontal expansion may lead to fragmentation of services, where synergies may be harder to obtain. The success of Norwegian so far was dependent on the ability to capitalize on a shared customer base and a web site hub. A challenge for further growth may be to stay away from new services which may be profitable, but do not link naturally into this infrastructure. Another concern is that the integrated innovation model is dependent on managers who have a truly corporate view, and employees avoiding silo thinking and turf wars. Whether this culture is sustainable, as the company grows into an international corporation, will be a major challenge for the managers in the future.

Finally, at the organizational level the simple bus structure, resembling Mintzberg's *Simple Structure Organization*, with little or no infrastructure, informal division of work and coordinated by direct supervision (Mintzberg 1983). It obviously cannot be scaled up to a major corporation, both for managerial and cultural reasons. Or can it? There may be interesting lessons to learn from how Norwegian handled the establishment of the bank, where only the core activities and technology were brought into the company structure. All the rest was outsourced, to maintain the simplicity of its bus structure. The point is that, in contrast to Mintzberg's model, the Organization Bus handles a large organization with a complex infrastructure, a highly differentiated division of labor—co-ordinated not by direct supervision but by a multi-layer infrastructure.

6 Conclusion

In this paper we investigated the relationship between ICT infrastructure and innovation. We built on two different research contributions; the concept of the enterprise service bus and the research on modular organizations.

We used *the* enterprise service bus topology to describe an innovation strategy at the Norwegian Corp. Based on this case study we show that the bus topology supports (i) a systems architecture which is flexible and robust, (ii) an innovation infrastructure which allows the company to innovate new services on the technical infrastructure and (iii) a lean and simple organization structure that connects the right people and resources.

Each of the three levels may seem simple and even intuitive, and Norwegian was certainly not the inventor of these structures. What distinguishes Norwegian from other similar initiatives is the consistency of the approach and the interplay between the three levels. We propose that a shared topology of these three levels is important to support the overall innovation process. Thus, in order to facilitate innovation it is not sufficient to establish a service oriented ICT architecture, if the two other levels are not aligned.

We also identified a number of challenges associated with the enterprise service bus approach, in particular related to scalability and the dependence of key personnel to maintain the simplicity of structure. Further research should look into similar cases, in order to investigate the attributes and mechanisms of multi-layered structure described in the Norwegian case. In particular, the concept of shared topology at different levels should be tested.

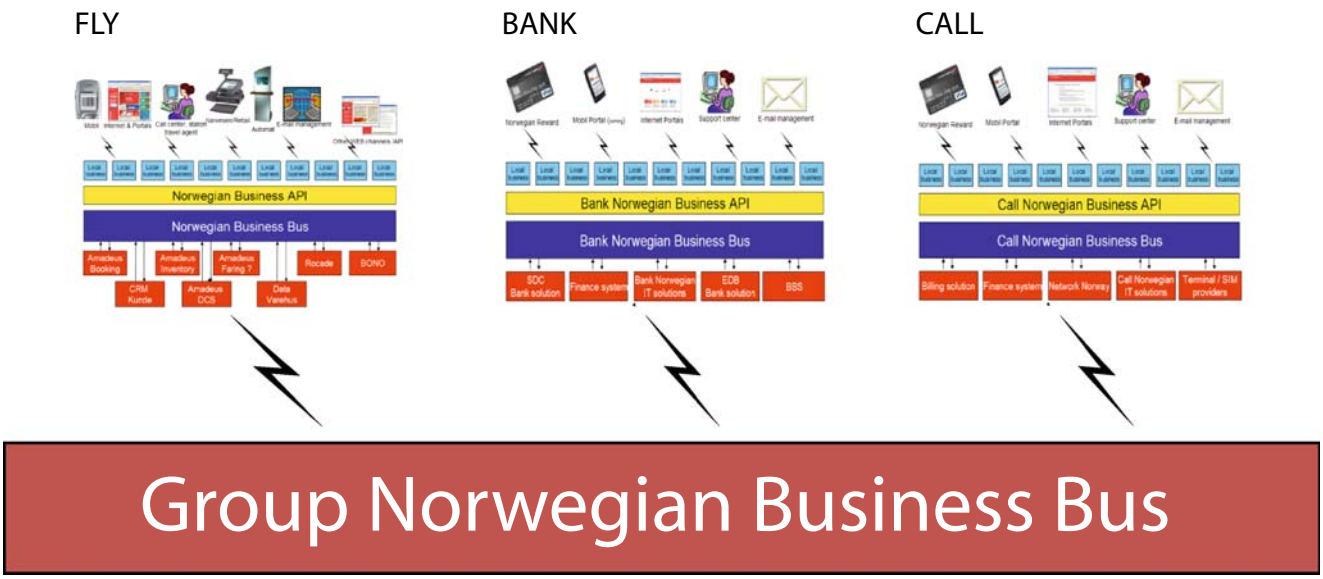

Fig. 5 The corporate business bus

References

Baldwin, C. Y., & Clark, K. B. (1997). Managing in an age of modularity. *Harvard Business Review, 75*(5), 84–94.

Beniger, J. R. (1986). *The control revolution: Technological and economic origins of the information society*. Cambridge, MA: Harvard University Press.

Cai, H., Chung, J., & Su, H. (2008). Relooking at services science and services innovation. *Service Oriented Computing and Applications, 2*(1), 1–14. doi:10.1007/s11761-008-0020-9.

Castells, M. (1996). *The rise of the network society*. Oxford: Blackwell.

Chappell, D. (2004). *Enterprise service bus*. Sebastopol, CA, USA: O'Reilly Media.

Ciborra, C. (2000). *From control to drift*. Oxford: Oxford University Press.

Cummins, F. A. (2002). *Enterprise integration: An architecture for enterprise application and systems integration*. New York, USA: Wiley & Sons.

Fulk, J., & DeSanctis, G. (1999). Articulation and communication. In G. DeSanctis & J. Fulk (Eds.), *Shaping organization form: Communication, connection, and community*, pp. 5–32. Newbury Park, CA: Sage.

Garud, R., & Kumaraswamy, A. (1995). Technological and organizational designs for realizing economies of substitution. *Strategic Management Journal, 16*, 93–109. doi:10.1002/smj.4250160919.

Hanseth, O., & Lyytinen, K. (2008) "Theorizing about the design of Information Infrastructures: design kernel theories and principles." http://heim.ifi.uio.no/~oleha/Publications/ISRinfrastructurefinal05-12-05.pdf, accessed: May 3rd 2008.

Iyer, B., & Davenport, T. H. (2008). Reverse engineering. Googles innovation machine. *Harvard Business Review,* (April), 59–68.

Langley, A. (1999). Strategies for theorizing from process data. *Academy of Management Review, 24*(4), 691–710. doi:10.2307/259349.

Langlois, R. N. (2002). Modularity in technology and organization. *Journal of Economic Behavior & Organization, 49*, 19–37. doi:10.1016/S0167-2681(02)00056-2.

Lawrence, P. R., & Lorsch, J. W. (1967). Differentiation and Integration in complex organizations. *Administrative Science Quarterly, 12*(1), 1–47. doi:10.2307/2391211.

Marks, E. A., & Bell, M. (2006). *Service-Oriented Architecture (SOA): A planning and implementation guide for business and technology*. New York, USA: Wiley & Sons.

Markus, M. L., Manville, B., & Agres, C. E. (2000). What makes a virtual organization work? *Sloan Management Review, 42*(1), 13–26.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis*. Thousand Oaks: Sage.

Mintzberg, H. (1983). *Structures in fives: Designing effective organizations*. Englewood Cliffs, USA: Prentice-Hall.

Parnas, D. L. (1972). On the criteria for decomposing systems into modules. *Communications of the ACM, 15*(12), 1053–1058. doi:10.1145/361598.361623.

Pettigrew, A. M. (1985). Contextualist research and the study of organizational change processes. In E. Mumford, R. Hirschheim, G. Fitgerald & A. T. Wood-Harper (Eds.), *Research methods in information systems*, pp. 53–78. Amsterdam: North-Holland.

Ross, J. W., Weill, P., & Robertson, D. (2006). *Enterprise architecture as strategy: Creating a foundation for business execution*. Harvard Business School.

Schilling, M. A. (2000). Toward a general modular systems theory and its application to interfirm product modularity. *Academy of Management Review, 25*(2), 312–334. doi:10.2307/259016.

Tidd, J., & Hull, F. M. (2003). *Service innovation. Organizational responses to technological opportunities & market imperatives*. London: Imperial College.

Zhao, J. L., Tanniru, M., & Zhang, L.-J. (2007). Services computing as the foundation of the enterprise agility: Overview of recent advances and introduction to the special issue. *Information Systems Frontiers, 9*, 1–8.

Bendik Bygstad holds a PhD in Computer Science from Aalborg University and a Master of sociology from the University of Oslo. He worked 15 years in the computer industry, mostly as an IT manager. He is currently an associate professor at the Norwegian School of Information Technology. His main research interest is the relationship between information systems and innovation.

Hans-Petter Aanby is Chief Information Officer, Head of IT and business development at Norwegian. He serves as Member of the Company's Management Board. Aanby's responsibility has been to set up an IT and business strategy for the corporation based on a flexible business oriented IT platform.