SMART BUSINESS NETWORKS
a new Business Paradigm

SBN 2006 Discovery: The Collected Papers

These proceedings represent the many and interesting papers that have been submitted and reviewed during the three days meeting in 2006. Authors were able to amend their papers based on these reviews and discussions. Where applicable the rapporteur for each session has included the comments and discussion points. The proceedings report separately on the various group sessions and theme discussions.

PETER VERVEST  ERIC VAN HECK  KENNETH PREISS - Smart Business Networks

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Smart Business Networks

A new Business Paradigm
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Sbni 2006 Discovery: The Collected Papers

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Peter Vervest
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Introduction

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A new business paradigm powered by smart networks

Representatives from science and business, combined in the Smart Business Network Initiative (“SBNi”), met for the second time at the Vanenburg Castle, Putten, the Netherlands from 14 to 16 June 2006. We brought to the meeting the cordial memories of the very successful inaugural meeting in May 2004. At that time we gathered as freshmen, a small group of scientists, many not known to each other, not really sure what that first, exploratory meeting was going to bring. We left the castle inspired and excited: New technology was going to open entirely new dimensions to the concept of “the business network”. As scientists from very different fields we combined complexity theory, information systems and organisational change theories in order to grasp what businesses should do extremely well in this world of networks: We tried to understand the invariants for organisations - and people - to succeed in this interconnected world. We coined the phrase “business operating system”: The idea that the organisation should segregate the logic of its behaviour from its actual execution. The interconnected world required agile business processes to be run and managed across different organisational domains, linked together dynamically in ever-changing networks. It would be very different from the management issues regarding more or less stable, or static, value chains. New management methods - and tools - would be required to be able to change processes on-the-fly while ensuring satisfactory results in a dynamic grouping of the business network.

Since then we have worked together over the globe to try to unravel some of the key issues that we identified, such as the enabling technolo
gies, the design, execution, governance, and outcomes of such “smart” business networks. We called it “smart” to emphasise “better than usual” results, novel, innovative cooperation, but also temporary and time-bound. Smart business networks can give performance that the individual actor cannot achieve on his own: The network exposes results from the actor's behavior that the actor himself is not aware of. Cars on a road, close to-
gether, can be seen as a wave from above, but as the driver of a car you do not see, or experience, that wave. Companies, close together in a business network, can exhibit behaviour without themselves being aware of their behaviour: Collectively they expose “swarm intelligence” (Bonabeau 2001) in a way that makes these companies, as a network, very strong, instantly present, and highly agile, yet the network may also quickly dissolve, disappear, and do something entirely different.

We acted in the same spirit of speed, strength and adaptiveness as we published our shared findings in our well-received book *Smart Business Networks* (Vervest, Van Heck, Preiss, Pau, eds., 2004): Our publisher Springer was surprised that his organisation could act so swiftly. A few months later, at the Cordys Cordial conference, October 2004, we could present the first sample of the book to our formidable host of the first SBNi get-together, Mr. Jan Baan, founder and chief executive officer of Cordys. The best papers were published in the special issue of *Journal of Information Technology* in December 2004 (Vervest et al., 2004).

The Smart Business Network Initiative

We spoke with many academics since the initial event in 2004. We met many business people, top executives, information officers, change agents, thought leaders, consultants. They made us understand that our thinking is different and our approach is different. If networks are self-organising, adaptive, can learn and change from within, without disruptive pain, if networks can develop their own form of intelligence, what would that mean to them, to the old, or traditional, way of organising, in companies, in universities? Are functional organisation and time-based specialisation outdated? Is the organisational paradigm developed by Taylor and Fayol (Vervest, Dunn, 2001), and that did so well, for so many years, finally breaking? What should be done?

As a result of that interaction we formed the Smart Business Network Initiative (http://www.SBNiweb.org) combining at a world-wide level, professors, PhD students and businesses to develop as, a *smart web of interest*: Professors share their research themes; PhD students present their research work, and companies tender their issues with the objective to provide breakthrough “theory and practice development” in this important field.

SBNi offers companies access to the important academia in this field and facilitates knowledge development on a global scale. SBNi organises *Discovery Sessions* to provide a platform for exchange of ideas and people.
Companies are invited to join as members and to search for PhD students who they may wish to commission for specific assignments. PhD students benefit from access to real company data that can be used for their research.

As an example: One of the largest financial institutes in Europe commissioned SBNi to assist in applying network theories to their traditional business with the aim to generate innovative approaches for rapid business development. SBNi created a “smart-wiki” which combines high-potential talents from this company’s talent pool, and many PhD students from over the world. Jointly they “write” the journal, or road map, that this company must take while embarking on its future. PhD students gain invaluable access to real-life data, professors to provide new research directions and build their theories. As a result the company has a safe compass for venturing into the networked world. Most importantly, an entirely new research engine is being created that links university research and company development in a different, more real and real-timed, environment.

SBNi 2006 proceedings

We are pleased to present the Collected Papers SBNi 2006 Discovery published by Erasmus Research Institute in Management, ERIM. These proceedings represent the many and interesting papers that have been submitted and reviewed during the three days meeting. Authors were able to amend their papers based on these reviews and discussions. Where applicable the rapporteur for each session has included the comments and discussion points. The proceedings report separately on the various group sessions and theme discussions.

The papers show that good progress has been made since 2004. The Program Committee (under chairmanship of professor Eric van Heck) has selected 6 papers to be specifically reviewed with the aim to publish these in a special issue of a leading academic journal. Many of the ideas developed during the conference have inspired Eric van Heck and myself to author a lead article for the Communications of the ACM, published June 2007 (Van Heck and Verve, 2007).

We have invited all authors to re-submit their papers, amended with the latest insights, to the SBNi 2008 conference: We have contracted with Springer Publishers to publish the best SBNi 2008 papers in bookprint. All submitted and accepted papers will be published as Collected Papers by ERIM and University of Tsinghua.
These proceedings have been the result of real networking, the links going back and forth between different editors, reviewers and authors. It proved difficult to maintain the sense of urgency, the speed and agility that we demonstrated in the first book. On behalf of the SBN 2006 Programme Committee I would like to thank all authors and reviewers for their good work - and patience - in assisting us to create these proceedings. We are also indebted to Peter de Wit, student at our school, for his persistence in finishing the job. Thanks to Ria Visser the proceedings have been completed in a professional way.

SBNi 2008 Beijing

At the time of completing these proceedings, the SBNi Programme Committee and Organising Committee are very much engaged in preparing the SBN 2008 session in Beijing: The academic programme takes place from evening Sunday 18 to Tuesday 20 May 2008 followed by an optional company visiting program from Wednesday 22 to Friday 23 May. We are grateful that the University of Tsinghua has offered to be our host for this unique, promising and very international programme. We invite you to register at the website (www.sbniweb.org/Beijing) or contact us via email at rvisser@rsm.nl.

We hope to welcome you all in Beijing!

Rotterdam, January 2008

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3. Smart Business Networks: How the Network Wins

By Eric van Heck and Peter Vervest

Introduction

An open digital platform where companies can do business across a network with anyone, anywhere, anytime, despite different business processes and computer systems? Once a dream, digital networks are now a rapidly maturing reality. These digital networks can expose unexpected behavioral properties of the individual actors. Combined as a swarm networked businesses are able to generate exceptional or “smart” results that they were not be able to perform before. Companies make different linkages, combine different capabilities from many different parties, are more agile, and move positions faster. What are these “smart” business networks and why are these important? What should chief information officers and professionals do to help their companies win in a networked world?

Be Smart In the Business Network

In less than ten years Amazon moved from electronic book retailing to become the world leading “e-tailer”. Without stores and with limited inventory, Amazon probably has more information on retail goods and their buyers and sellers than many other businesses. Amazon offers a business platform for the traditional retailer to “make a market” [9]. Within the Amazon business networks, the retailer can:

1. facilitate search by buyers and sellers;
2. discover and help set pricing and other transaction conditions;
3. manage and coordinate the logistical processes for transfer of the physical or digital goods;

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1 We would like to thank Al Dunn for improving a previous version of this article. This article is based on our work as discussed in the Smart Business Network Initiative (www.sbniweb.org). We thank all the members of SBNi but in particular Chris Holland, Benn Konsynski, Kenny Preiss, and Li Zheng.
4. settle payments and arrange fund transfer;
5. authenticate the quality of the goods sold and verify the credibility of
buyers and sellers.

Thousands of electronic retailers join Amazon every month for all or
some of these functions. At the same time many leave, or are rebuked by
the Amazon system. Amazon facilitates product representation, regulatory
compliance, risk management, and conflict resolution. It has acquired a
reputation for trustworthy transactions by fact - not fiction. eBay, with
over 222 million registered buyers and sellers, has done the same for auc-
tions. At the end of 2006, Skype had attracted 171 million registered users.
In less then four years Skype has surpassed anything any traditional tele-
phone operator has ever achieved.

These companies offer “platforms” on which users can freely move and
interact as long as the platform provider allows them. These platforms
show a strong “network effect”: The more users, the more useful the net-
work becomes, the harder it becomes to switch, and the less likely the user
will move to another network. Albert-László Barabási [1] recognized this
by analyzing internet traffic. He demonstrated that the net is not demo-
cratic, and the number of links per node follows a so-called power law dis-
tribution. A few nodes have many links while many more other nodes have
very few links. The node with many links attracts nodes with fewer links
faster than the lesser-connected nodes. As the big get bigger, what options
do the smaller actors have?

Kenny’s Bookshop & Art Gallery is a family run small business in Gal-
way, Ireland (www.kennys.ie). It sources valuable second-hand books and
sells them to interested collectors [5]. Established in 1940, Kenny’s began
focusing on its bookshop customers and then, in the 1970s, by mailing pa-
per catalogues to libraries overseas. In 2003 Kenny’s linked its library
management system to the Online Computer Library Centre (OCLC), a
not-for-profit organization that owns the largest database of bibliographic
records in the world. They were the first to have a commercial arrange-
ment with OCLC. This allowed them to provide a full electronic catalogue
on virtually any second hand book highly efficiently and faster than any-
one else. They reaped instant financial rewards since a catalogued second-
hand book is usually valued four times higher than an un-catalogued item.
Through Bookrouter.com Kenny’s published its rapidly growing stock of
now-catalogued second-hand books on multiple internet sites such as
Amazon, Alibris, and Bibliodirect, using their, or other logistics providers,
physical delivery capabilities. In 2006 Kenny’s bookshop went completely
online and their shop in Galway is now just hosting the art gallery.
Kenny’s could have remained a traditional bookshop with others - Amazon and eBay - capturing their business. They did the reverse. They became “smart in their business network” by capturing a valuable position and leveraging that position across as many links as they could.

Capturing and leveraging a position in a business network does not mean that one has to own, or control, the platforms on which those networks run. TheBigWord company (www.thebigword.com) is able to serve the diverse translation needs of large companies worldwide by sharing a “translation memory” across a network of its clients and thousands of local “mother tongue” linguists [7]. It responds almost instantly to translation needs - such as for publishing on websites in many different languages - by posting the work to targeted groups of qualified translators, dividing and allocating the work, and managing the process in a way that is fully transparent to the client. TheBigWord rewards the translators by paying by the number of words they translate and by providing their administration and payment services. TheBigWord example shows that these business networks can respond with much more agility together than acting as an individual company. But what are other characteristics and what are the reasons why these new forms start to be developed and implemented now?

A New Business Network Approach

Organizations are moving, or must move, from today’s relatively stable and slow-moving business networks to that open digital platform where business is conducted across a rapidly-formed network with anyone, anywhere, anytime despite different business processes and computer systems. Table 1 provides an overview of the characteristics of the traditional and new business network approaches. The disadvantages and associated costs of the more traditional approaches are caused by the inability to provide relative complex, bundled, and fast delivered products and services. The potential of the new business network approach is to create these types of products and services with the help of combining business network insights with telecommunication capabilities.

The “business” is no longer a self-contained organization working together with closely coupled partners. It is a participant in a number of networks where it may lead or act together with others. The “network” takes additional layers of meaning – from the ICT infrastructures to the interactions between businesses and individuals. Rather than viewing the business as a sequential chain of events (a value chain), actors in a smart business
network seek linkages that are novel and different creating remarkable, “better than usual” results. “Smart” has a connotation with fashionable and distinguished and also with short-lived. What is smart today will be considered common tomorrow. “Smart” is therefore a relative rather than an absolute term. Smartness means that the network of co-operating businesses can create “better” results than other, less smart, business networks or other forms of business arrangement. To be “smart in business” is to be smarter than the competitors just as an athlete who is considered fast means is faster than the others.

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<th>Traditional Business Network Approach</th>
<th>New Business Network Approach</th>
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<td>Relative complex, bundled, and fast delivered products and services</td>
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Table 1: Characteristics of Traditional and New Business Network Approaches.

Another dimension the new business network approach distinguished itself is the way the network is orchestrated. In Sidebar 1 Javier Busquets, Juan Rodón, and Jonathan Wareham introduce the Spanish Grupo Multiasistencia. The sidebar shows how the smart business network approach with embedded business processes lead to substantial business advantages. The sidebar also shows the importance of information sharing in the business network and the design and set up of the infrastructure.

The pivotal question of smart business networks concerns the relationship between the strategy and structure of the business network on one hand and the underlying infrastructure on the other. As new technologies, such as RFID, allow networks of organizations almost complete insight into where its people, materials, suppliers and customers are at any point in time, it is able to organize differently. But if all other players in the network space have that same insight, the result of the interactions may not be competitive. Therefore a first critical step is to develop a profound understanding about the functioning of the business network.

Understanding the Network

If two cars drive on the highway with enough distance between them they have no relationship other than to share the same tarmac. If, however, these same cars get very close, they start behaving differently. If the first car brakes, the second car will brake - but with a delay. If the first car accelerates, the second car will also speed up; again, with a delay. The drivers of these two cars may not notice much more than the distance between them. But from a helicopter their behavior will show as a “wave” moving along the flow of traffic. Each participant does not see the behavior of the network but responds to the local situation with his/her driving logic.

The impact of the individual driver’s actions in response to their specific situation and the road rules that they follow creates a collective network behavior not seen nor understood by the individuals. Each driver acts on self-organizing “driving logic” according to the “driving rules” of the network.

The study of networked behavior beyond the familiar territories of business and ICT networks – those of social interactions, ant colonies, bees, biological systems – reveals attributes and characteristics which can be applied to the design of smart business networks.

The behavior of the individual drivers, above, demonstrates “swarm intelligence”: the emergence of seemingly intelligent or, perhaps, smart, be-
behavior from many individuals [2]. Swarm intelligence studies collective behavior in self-organizing systems populated by simple individuals interacting locally with one other and with their environment without centralized control. However, in many cases, despite being unpredictable, such “swarms” are able to exhibit impressive capabilities for problem solving to, for example, seek food or respond to an unforeseen problem.

While these studies provide indicators for network dynamics – formation, change, decay – and for the ways in which the individual intelligence of the network actors is combined the research in social network analysis have made major contribution to a more profound understanding of network behavior. Social network researchers take into account the social relationships and ties of individuals and therefore the structure of the network. Building on social network analysis using complex systems theory Dan Braha and Yaneer Bar-Yam [3] examined the statistical properties of large-scale product development information networks for vehicle design. They find that such networks have properties (sparseness, small world, scaling regimes) like those of other biological, social, and technological networks. They demonstrate that the distribution of incoming communication links always has a cut-off – their numbers are restricted - while the distribution of outgoing communication links is so-called scale-free, i.e. some nodes act as “highly connected hubs”. This would be consistent with Herbert Simon’s bounded rationality-argument that rational agents experience limits in formulating and solving complex problems and in processing (receiving, storing, retrieving, transmitting) information.

Braha and Bar-Yam found that it seems easier to transmit information than to process information. Like individual human beings a group of people, or network of nodes, are limited by an inability to digest an intense input of data. It seems that “smartness” could be related to the capability to organise the information flows within the business network as well as to the topological structure of the network.

Other researchers have shown the attractiveness and importance of certain positions in the network, i.e. those nodes that are dominant and those that take subservient roles. For example, in 1992, Ronald Burt identified “bridging positions” where the network participants link through a focal actor who holds the bridge [4]. This structure brings information and control benefits (a central player) but also encourages the dependent actors to find alternative routes, i.e. to disintermediate the bridger.

As the analysis is applied to larger and more complex networks more advanced ways are required to analyze the structure of the network. In Sidebar 2 Diederik van Liere and Otto Koppius use social network analysis and simulation techniques to explore the concept of the “network horizon”: the number of nodes that an actor can “see” from a specific position in the
network [11]. With a larger network horizon a company can take a more advantageous network position depending on the distribution of the network horizons across all actors and up to a certain saturation point. The results indicate that the expansion of the network horizon will be in the near future a crucial success factor for companies.

Most of these network scientists analyze the structure and dynamics of the business networks independent of the technologies that enable it to perform. It concentrates on what makes the network effective, the linked relationships between the actors, and how their intelligence is combined to reach the network’s goals. Digital technologies play a fundamental role in today’s networks. They have facilitated improvements and fundamental changes in the ways in which organizations and individuals interact and combine as well as revealing unexpected capabilities that create new markets and opportunities. One need only consider the rapid rise in digital social networks and massive online computer games such as Second Life. These are exhibiting capabilities that seem well beyond those of existing business networks.

The next critical step is to develop a profound understanding about the expected smartness of the business network.

**What Makes A Smart Business Network?**

The key characteristics of a smart business network are that it has the ability to “rapidly pick, plug, and play” to configure rapidly to meet a specific objective, for example, to react to a customer order or an unexpected situation (for example dealing with emergencies) [12]. One might regard a smart business network as an expectant web of participants ready to jump into action (pick) and combine rapidly (plug) to meet the requirements of a specific situation (play). On completion they are dispersed to “rest” while, perhaps, being active in other business networks or more traditional supply chains.

This combination of “pick, plug, play and disperse” means that the fundamental organizing capabilities for a smart business network are: (1) the ability for quick connect and disconnect with an actor; (2) the selection and execution of business processes across the network; and (3) establishing the decision rules and the embedded logic within the business network.
Quick Connect, and Disconnect

“Quick connect” requires that, as a result of an event the smart business network must seek and select those members who, together, can fulfill the required goal. This means that the network logic acts on a menu of potential fulfillment partners to select those who can combine to produce the desired results. Once the appropriate participants are found and the connection has been established, the process of “play” - performing the business transaction - can begin. Goldman, Nagel and Preiss [6] described this in their discussion of Virtual Organizations. The capability of quickly connected plug-compatibility enables a superior response speed and greater component variety particularly for dealing with new requirements.

While the ability to “quick connect” has received attention, the capability to “quickly disconnect” requires more. Members will join the business network and participate on the basis of risk and reward. While this can be clear while they are active rules should be agreed upon for when the actors are disconnected (having completed a specific customer order or while they will not be longer a member of the network). Decision rules and logic with regard to connection and disconnection will be a crucial component for the success of the business network.

Plug and play – bringing the network together

When selected, the network participants must be able to interoperate. They must be “plugged” together to enable the required network outcome. This means that they must act with “modularity”: the decomposition of a system by grouping elements into a smaller number of subsystems with rules governing the architecture for mixing and matching these components.

The concept of modularity has a long history in product design and manufacturing enabling product construction of tailored products from “standardized” components: the combination of Lego-like modules that are combined in a specific way. Modularity brings the benefits of versatility (the diverse set of products that an organization can produce) and agility (the ability to respond quickly to fulfill an unpredictable customer order) while, at the same time, delivering within the boundaries of allowed value chain total costs and lead times. Martijn Hoogeweghen et al. developed based on modularity principles a method to design modular business networks and to optimize the allocation of tasks in a business network [8]. The network nodes will be considered as “black boxes” providing the functionality required by the business network and are “played” according to the network rules. However, modular design requires much more coor-
dination than non-modular: the greater the number of components the higher the organizing cost. A crucial decision is the degree of modularity or granularity of a system, or business network, and that is determined by the balance between coordination costs and the complexity of the network.

**Embedded Business Logic**

Each business network participant has specific capabilities captured in its business processes (own business logic) that it executes according to this logic. Traditionally, when such participants combine they create interfaces between capabilities: translating from one business logic to another and executing according. This can be seen in the outsourcing phenomenon: carve out the total function of a particular business operation and hand it over to another party. As indicated before traditional business network approaches lack the ability to “rapidly pick, plug, and play” to configure rapidly to meet a specific objective, for example, to react to a customer order or an unexpected event. Figure 1 presents part of a global business network. Its focus is on the actors and relationships from manufacturers via multi-modal transportation (road, train, seaship) to retailers. In most current business networks companies developing capabilities at the logistics layer and the transaction layer. As discussed in Table 1, these actors focus on their direct partners and are not able to have the end-to-end management of processes running across many different organizations in many different forms. The actor platforms are dominated by “information silos” residing either in different places within an organization as ‘islands’, or in two or more different organizations. Individual actors are orchestrating processes in their part of the supply chain.
Figure 1: The Traditional Business Network Approach

Figure 2 presents the situation in case of using the new business network approach. Central idea is that linking partners is on the basis of linking processes but allowing individual execution according to those processes: they act individually according to the joint rules of the network.

In other words each of the smart business network participants becomes a “smart insect” in a goal-seeking swarm. The network separates process from execution. It shares the processes required to achieve its goals (the shared business logic) allowing each participant to execute in its own way according to this logic. This means that, to be a member of the network, an organization must be able to absorb the shared logic and execute accordingly. This is the “own business logic” of the network that can be enabled by a Networked “Business Operating System” (BOS). Based on the service-oriented architecture it resolves the problem of “information silos” by loose-coupling of underlying systems, which are connected together in a business operating layer. This layer allows process execution and management “from a distance” from the underlying application systems. The enabling inter-organizational technology architecture must reflect this loose-coupling. Loose-coupling is not synonymous with decentralized processes. It is quite the opposite, where the processes are more tightly coordinated because the rigidity of the IT architecture is no longer a constraint [10]. The business operating layer can become rather complex due to the fact that business logic is developed related to such issues as:
• **Membership selection**: the capabilities to decide which business entities can act as nodes of the network;
• **Linking**: the positioning and connecting of nodes to the other parts of the network. The linking processes can include the directories (search and select) and routing (path finding) through the network as well as typical communications tasks such as handshake, authentication, and trust establishment;
• **Goal setting**: the coordination mechanisms that determine goals in the business network and the tasks and responsibilities assigned to each member node;
• **Risk and reward management**: the division of material results (profit and loss in a monetary but also in a fairly loose and generic sense) and the perceived value by each of the participating business entities of its share;
• **Continual improvement**: the capabilities and processes of joining and leaving the network over time, of network renewal and sustainability.
• **Fault tolerance**: to malfunction of a node, for example a business malfunction or bankruptcy.

Figure 2: The New Business Network Approach
The concept of a BOS is analogous to that of the computer operating system. The invention of an operating system for the PC in the 1970s allowed application software to be run on different computers as long as they conform to the rules of the operating system. Implementation of a BOS enables the portability of business processes and facilitates the end-to-end management of processes running across many different organizations in many different forms. It coordinates the processes among the networked businesses and its logic is embedded in the systems used by these businesses.

Questions for the CIO

For those recognizing the promise, or necessity, of capturing the capabilities of smart business networks to be proactive and effective in this largely unmapped territory of “being networked” the fundamental questions are:

1. What are the characteristics of smart business networks and how is the “own” business network functioning?
2. What are the key enablers and what have to be the expected smartness of the business network?
3. How to capture the business logic and what are the potential functionalities of the Networked “Business Operating System” and how to create this business operating layer?
4. What are the important trade-offs that need to be analyzed and decide upon?

With regard to the last question, we have defined a set of important trade-offs and related specific questions that need to be answered with regard to the business network outcomes, execution, governance, design, and enabling technologies. Table 2 provides the trade-offs and critical questions.

<table>
<thead>
<tr>
<th>Issues</th>
<th>Trade-offs</th>
<th>Critical Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network outcomes</td>
<td>Preferred versus expected outcomes</td>
<td>What do customers want in terms of products and services (quality, complexity, bundling, delivery time,</td>
</tr>
</tbody>
</table>


### Table 2: Critical Trade-offs and Questions with regard to Smart Business Networks

<table>
<thead>
<tr>
<th>Network execution</th>
<th>Network versus individual outcomes and performance</th>
<th>price, offline/online)? How to value customer demand?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Individual versus network execution</td>
<td>What can we offer to customers in terms of products and services (quality, complexity, bundling, delivery time, price, offline/online)?</td>
</tr>
<tr>
<td></td>
<td>Simple versus complex transactions</td>
<td>What actors will work together to fulfill the customer order? How?</td>
</tr>
<tr>
<td></td>
<td>Global versus local execution</td>
<td>What level of modularity is required?</td>
</tr>
<tr>
<td></td>
<td>Integrated versus modular products/services/processes</td>
<td></td>
</tr>
</tbody>
</table>

| Network governance | Central governed versus adaptive, self organizing | Who is responsible for the customer order? |
|                   | Governance to innovate versus governance to operate efficiently | How are decision rights delegated? |
|                   |                                                   | How is the relational governance evaluated? |

| Network design | End-to-end control versus individual control | How to keep end-to-end control in the network? |
|               | Networked business operating system versus actor business operating systems | How to design and test the networked business operating system? |
|               | Global versus local adaptation                | How to deal with the environmental and internal dynamics of the business network? |
|               | Dynamic versus static business network         |                                                   |

| Enabling technologies | Open technologies versus closed technologies | What technologies will be disruptive for the business network? |
|                       | Individual versus network technology adoption | How to speed up technology adoption in the business network? |
The Challenge Ahead

We may believe that we are familiar with the networked world. However, in recent years our understanding has been disturbed by the rapid emergence of digital social networks - a seeming swarm of consumers who are interacting in ways beyond that of most organizations. The pressures of global competition and the need for effectiveness and agility demand new ways to organize. Companies must develop and act “smart” in rapidly changing and expanding business networks enabled by today’s pervasive communications technologies. Chief information officers and professionals must span the boundaries between their own organization and the growing networks in which their organizations operate. They must understand new vocabularies that are not necessarily technically or business oriented. Decision making in very large networks is fundamentally different from what we are used to. Understanding how federated activities emerge and operate is not a monolithic discipline and requires the CIO to become a different animal, once again!

References


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Sidebar 1

Multiasistencia: The Network Orchestrator

By Javier Busquets, Juan Rodón, and Jonathan Wareham

Operating in Spain, France, UK, and Portugal, Grupo Multiasistencia coordinates home insurance claims and repairs serving some 9 million customers. Founded in 1983, its group managed small trade professionals and has evolved to become a service coordinator for over a hundred large corporations including insurance companies, banks, department stores, and other retail chains. European end customers and corporate clients are handled by its Madrid-based control center. Its 375 Customer Service Representatives (CSR) receive requests for home repairs by phone, e-mail, or the Internet. They deploy and control jobs to a network of 11,000 trade professionals who complete the repairs. Figure 1 explains the main actors in the business network.
After Multiasistencia’s success in managing collectives and attracting corporate clients it experienced in 2000 declining quality resulting from the non-scalability of operating all their communication via the telephone. In that year the new CEO and CIO started to re-engineer using the newest information and communication technologies [1]. The result has been a Networked Business Operating System (BOS) based on their Call Center, Internet, Web Services, and Mobile Systems. The network coordination is highly automated. On a repair order no one needs to intervene unless an exception occurs. The BOS tracks more than 100 variables to assure quality standards and timely execution. With this automated coordination, productivity increased to 49.6% and the number of errors dropped dramatically. The firm has automated almost all human communication except for incoming calls. Therefore the CSRs do not manage phone calls, they monitor the processes to manage exceptions to ensure quality. With the intense use of ICT, particularly Web Services, connected and disconnected processes have been integrated and standardized.

Rather than technological a major challenge in implementing the BOS has been ensuring trust with the agents given the higher levels of standardized processes and transparent control. The BOS also has the capacity to adapt to environmental changes by defining behavioral limits as automatic responses or human-driven actions for exception management. In addition the BOS accommodates idiosyncratic corporate customer demands as turnkey services. All services are audited through SLAs with all agents in the network. In addition Multiasistencia has boosted value and innovation by collaborating with its corporate clients [2, 3]. 80% of new software development has been done in collaboration with its large customers. For example, in 2005, it created a new desktop telesurvey adjustment service. When the repair assessment goes above a financial threshold, loss adjusters can carry out a “desk-top audit” on the Internet; digital photographs are taken on-site by trade professionals, sent to the CSR, and reviewed for approval in real time.

In 2006, with a European insurer and Multiasistencia defined a new service to inform end customers about the process whenever a claim was presented. The application sends Short Message Services (SMS) messages through cell phones to the end customers. As one of the insurer’s executive explains, “Information management has been the key to increasing loyalty by 20% with our customer base whenever they use the service.” Trade pro-
professionals also benefit. They use digitalized signatures and electronic invoicing, thereby improving cash collection and reducing administrative costs by 40%.

Besides the productivity gains, this smart business network has also standardized the highly fragmented and heterogeneous household repairs sector: applying pre-defined prices, transparent conditions, service performance and quality guarantees, ensuring timely response (24 hours and 3 hours for emergencies) and warranting the work for 6 months.

There are two critical challenges for Multiasistencia to support the business model and the business relationships. The first challenge is the interfacing of the BOS with human agents. The second challenge is negotiating and finding a balance between standardization and innovative environmental responses.

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Sidebar 2

Network Horizon and Obtaining a Favorable Network Position

By Diederik van Liere and Otto Koppius

In the networked world decision-makers must ensure that their companies understand their position in the business network. They should see their company as a node in much larger networks of interdependent firms which are constantly being reconfigured. It implies that decision-makers must be acutely aware of their position in the network; not only the direct (supplier or client) contacts but also the contacts’ contacts, their contacts etcetera. The number of nodes that an actor can “see” from a specific position in the network is called the network horizon. Figure 1 explains how the network horizon of Firm A is expanded using the opportunities of the bridging position in a business network. Our studies have shown that the network horizon is an important determinant of both individual firm performance and the overall network dynamics and performance.

Research is carried out by developing a management game called the Business Networking Engine [2] that can be used to test the effects of new, networked organizations based on the concepts of modularity and loosely-coupled business processes. A series of experiments with executives from the insurance industry showed that firms with a higher network horizon achieved higher performance. These firms were able far better to spot favorable network positions where they could act as a bridge between different parts of the network: a position rich in structural holes [1]. Firms with a lower network horizon rarely identified such opportunities and hence had lower performance.
As the network adapts to its members responses to changing market conditions and competitor actions, the bridging position advantage may be temporary. So when does a network position confer a sustainable competitive advantage? Extensive simulation revealed that a key factor is the way the network horizon is distributed across the different firms (in other words the network horizon heterogeneity). The results are striking. Regarding the traditional supply chain where all firms have a low network horizon (i.e. firms know their direct upstream and downstream partners but little else), then a competitive advantage can be sustained for some time. However, when the network horizon becomes more heterogeneous, for instance because some firms start to think in network terms instead of supply chain terms, the situation changes significantly. In heterogeneous networks, a low network horizon confers little advantage but having even a modest network horizon can sustain a competitive advantage for some time. However, once all firms have a high network horizon, the network becomes homogenous again. Any opportunity can be spotted by many firms and any competitive advantage is short-lived.

These findings might explain why network orchestrators in a wide variety of industries are so successful. Companies such as Li & Fung in the apparel industry, Seselectron and Flextronics in semiconductors, and Grupo Multiasistencia in home insurance claims and repairs were among the first to see themselves as nodes in a larger business network. In a homogenous, low-horizon network, their extensive network horizon enabled them to po-
sition themselves as network orchestrators connecting otherwise discon-
ected parts of the network and becoming the powerhouses in their respec-
tive industries while others struggled to make the transition to network
thinking.

We foresee two challenges for organizational decision-makers seeking
the networked approach. The first challenge is to start to think about a
network strategy, rather than seeking competitive advantage based upon
internal capabilities. By choosing and maneuvering to the right network
position a firm can reap even more benefits from its current capability-
based competitive advantage. The second challenge is to identify which
networks are relevant for their business and where they can expand their
network horizon. As business networks continue to grow the whole net-
work cannot be scanned. Some parts of the network are more relevant than
other parts. As competitive advantage is increasingly network-based the
expansion of the network horizon will be in the near future a crucial suc-
cess factor.

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4. New challenges

Table discussion Al Dunn’s group

By Al Dunn and W Golden

Members:
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• Albert Douma (University of Twente)
• Arnoud van de Laak (RSM Erasmus University)
• Jorge Sanz (IBM Research)
• Katerina Pramatari (Free University Amsterdam)
• Marcel van Oosterhout (RSM Erasmus University)
• Matthias Fischer Vodafone)
• Ulad Radkevitch (RSM Erasmus University)
• William Golden (NUI Galway)

Introduction and defining SBN
The group began by agreeing the essential elements and characteristics of a smart business network. We agreed on the following.

While the principles of the SBN can be applied within an organisation we agreed that an SBN is interorganizational. An SBN is enabled by digital business technologies and organics using open (plug and play) interfaces and transparency. The linking of organisations within an SBN can be either ad hoc (e.g. based on individual transactions) or more longer term (as part of a partnership).

The partners in the SBN co-operate on the basis of achieving pre-agreed goals (win-win) with the network designed to meet these goals effectively and competitively. Trust is an important enabler for a sustainable SBN. Parties in the SBN can both compete and cooperate, depending on the goals of the SBN, the specific product/service delivered or their approach to the market.

A SBN combines “shapers” (one or more organizations who initiate and/or orchestrate the network) as well as “adapters” (organizations who comply to the requirements set by the shapers).
Smartness is a relative term, both in time and space: Today’s smartness can be dumb tomorrow. We understand "smartness" as outperforming competitors or competing business networks (in a specific time and space) in efficiency, effectiveness, revenues, joint profitability and/or competitive sustainability.

Smartness can be found in the business models and/or the technologies applied in the SBN. Examples of technologies which can be used as part of a smart enabling IT architecture are the semantic web, grid computing, service oriented architectures, web-based services, business operating systems, data mining tools, sensors and RFID. A smart business model can be a new model for coordination or a new market position previously unfilled (structural hole strategy).

A SBN is agile and can change and reconfigure over time – both within its existing structure (design and governance) as well as into a new structure (design and governance). One of the design factors which enables such reconfiguration is the use of commoditized/modularized routine operations (pre-established transactions). However, it is necessary to distinguish between cooperation based on pre-existing transactions or existing relationships and new forms of cooperation [designed ad-hoc] based on SBN capabilities.

As the research field of SBN’s evolves, we propose to develop and compare multiple case studies and, based on inductive thinking, develop qualified SBN theory. A distinction should be made between existing cases based on incumbents (e.g. the WinTel business web (Windows-Intel HW/SW platform), NTT Docomo (shaper),and SBN’s based on new players (for instance Hostelworld.com (intermediary for hostel reservations), Elance Online (online marketplace for IT services), smart containers (RFID, GPS, Sensors), Octopus (smart card Hongkong))

Central Question:
How do smart business networks outperform traditional networked businesses?

Scientific Challenges
We identified the following scientific challenges and issues for further research::
- Which business criteria can be defined to measure and make judgements on the level of smartness? For instance, the ability to increase scale quickly (via for example franchising) may be a measure for smartness.

- How to define out performance? What are the KPIs?

- What are the success factors and the benchmarks for outperformance?

- What type of incentive (and penalty) models are needed for SBN to out perform

- What kind of models and applications can be developed to involve the customer in order to maximize performance of the SBN?

- How are these to be measurement? How does one measure the performance of a group/network of businesses? What are the components of the SBN “dashboard”?

- Develop models where the network effects and economies of scope and scale are taken into account

**Business Applications**

We identified the following business applications:

- Trust enabling applications: since trust is one of the major enablers for SBN success, trust enabling applications and tools are needed. What do they look like, what are their components, how are they designed and implemented

- Business Network Operating System reconfigurators to quickly redesign products, services and processes based on predefined modules [what are these modules?]

- Business Model Design and Execution tools to assist SBN orchestrators to model and coordinate the SBN and convert the required business rules into software code, for example to support the necessary workflow among the participants in the SBN
Table discussion group D

By L-F Pau

Members:
- Al Dunn (D-Age)
- Dirk van Geisdorp
- Wolf Ketter
- Ting Li
- L-F Pau
- Kenneth Preiss
- Peter Vervest
- Henk ten Vorde
- Sheng Yun Yang
- Li Zheng
- Simon van Zijll

Focus: Principles for establishment of technologies enabling SBN’s

1. Paradigm

The discussion used as an implementation framework the following model for SBN services, with separation between the layers:

| Business Layer: Business partner selection, goal sharing and business execution (SLA, auctions, common ERP, agents,..) |
| Infrastructure: Grid and semantic Web resources, Transport networks |

The above two-layer model seems better suited to SBN execution than the ISO 6 layer model, where parties in a SBN must align all 6 layer implementations.

Also it was agreed that the strategy of some enterprises to harmonize and enforce all services in line with a common enterprise architecture (EA), is a recipe for lack of flexibility and excessive complexity. SOA service oriented architectures as collection of many elements fall into same category of bottlenecks. The word “infrastructure” includes the requirement that businesses can call enablers for transferring and sharing information-oriented resources without the need to know about the details of this transfer.
If two or more parties sharing a goal do not find in the infrastructure all they need to meet that goal (information, resources, servers, clearinghouses, etc.), they will need to invest increments to it, made open or not to others. Licensing of these increments can possibly be a source of future income, or be open to others to use.

Conversely, a denial or divestment action is implied when elements in the Infrastructure are not accessible (IPR, competitive positions, etc) or are obsolescent (information, resources).

The Business Layer actions are coordinated by control networks that are separate from transport networks. The management of the grid resides at that layer. This too provides for possible business opportunities in the future. This set-up aims at embedding business logic inside communications networks and has been studied already.

2. Some principles for establishment of technologies enabling SBN

1. Simplify the business layer processes to the minimum, in the interest of speed, transparency, and execution resilience

2. In designing and developing a resource to be used in the grid, the start point must be the business need, not the technology solution. In doing so, one should create the simplest technology solution commensurate with the business process need. One should avoid the temptation to add to the solution options currently not needed. It will often be useful to split the technology process into separate but connected modules

3. The smartness in SBN asks for simplicity but uniqueness even if this uniqueness is highly temporal

4. Interfaces between the Business layer and the Infrastructure must be ubiquitous and standardized in the interest of quick interoperability

5. The tools must be based on components and middleware to be configured according to above principles, and too tight integration is not to be aimed for
6. Interns of business, what is sold is not the SBN technologies but mostly the managed services at Business layer level (contracts, SLA’s, and BSS management functions)

7. Protocols in the Grid layer must be application neutral, lightweight but not always optimized

8. Total separation must be maintained between the business logic in the Business layer, and Infrastructure

3. Most relevant scientific subject

This was not really discussed in the group, but the priority suggestion is on the control and coordination protocols within the business layer, and between it and the infrastructure layer.

4. Most challenging business application

This was not discussed in the group as it focussed on technologies and not on applications. It may be that the most challenging aspect is how to profit from developing then licensing the use of business processes using a grid.

The group began by agreeing the essential elements and characteristics of a smart business network. We agreed on the following.

While the principles of the SBN can be applied within an organisation we agreed that an SBN is interorganizational. An SBN is enabled by digital business technologies and organics using open (plug and play) interfaces and transparency. The linking of organisations within an SBN can be either ad hoc (e.g. based on individual transactions) or more longer term (as part of a partnership).
What have we learned?

1) It is important to differentiate between chains, trees and nets. The figure shows graphs that are a net as it includes one or more cycles, a tree and a chain. A chain is a subset of a tree, which is a subset of a network. A tree has no cycles, and a chain is a special case of a tree with no branches at any node.

All these types of relationship can exist in a given situation, depending on the perspective and the level (or granularity) of observation. For example, one may see a network when viewing the relationship between three companies. When looking at these relationships from the perspective of high-level processes one may perceive a tree when looking from customer process to supplier process, but a chain when looking from supplier process to customer process. At the low-level process one may observe a network. For example, when viewed at the corporate level, we may observe that company A supplies to company B, and B to C and C supplies to A, a cycle relationship and hence part of a network. However, we may find that the supply is from process A1 of company A to B1 of B, and from process B1 to process C1 of C, then both B1 and 1 supply to process A2 of company A. This is a tree structure as shown in the figure. Alternatively process A11 of A may supply to B11 of B, that supplies to C11 of C, that supplies to process A22 of company A. This is a chain. At the same time, at a more detailed level, process A3 of company A may supply a basic component to all the processes mentioned above, making this a network structure. Some of the papers and discussion indicated that there is still some confusion as to these fundamental understandings.
2) If we are not careful, this subject of Smart Business Networks (SBN) could subsume all research into business processes. The subject of SBN is at a very early stage, but some effort should be spent defining, even if fuzzily, what it is and what it is not.

3) Jorge Sanz is of the opinion that a relatively small number of unit processes – he quotes XXX [fill it in ] – will enable definition of most business relationships.

4) It became clear that although executives or managers are legally responsible for the profit of a single company, which is a node in a network, they must see and understand the whole network if they are to carry out their responsibilities successfully.

5) From the presentation of Frank Elion of Delta Lloyd, we learned that when the configuration of an insurance company changed from a chain to a network, they could offer standard insurance at cheaper premiums than before. We conclude that a Smart Business Network can be economically more efficient than a supply chain, just as Voice over Internet Protocol (VOIP) uses communication infrastructure more efficiently than does Point-to-Point communication and hence allows cheaper voice communication.

6) Several papers showed useful results from the use of discrete mathematical methods, such as cellular automata, and graph theory. These are powerful methods and as they take their place beside methods based on
surveys and statistics, can deepen our understanding of processes within SBN’s.

7) Other methods being developed in computer science such as the use of semantic objects, have been shown to be useful in this field.

8) At this meeting, compared with the meeting two years ago, the shape of the subject of Smart Business Networks was clearer. Some papers related to business applications (including Busquets’ presentation of the Multiasistencia company and Elion’s presentation mentioned above) showed very clearly the commercial advantages of the SBN structure. However, the field is young and the concepts are still in the process of formation. We are still short on understanding the phenomena and the problems and hence the methodologies needed for SBN’s. The future holds promise both for enterprising researchers and for enterprising business leaders. Understanding then profiting from an SBN is a truly multidisciplinary affair. This is an opportunity for many people from many disciplines both to contribute and to profit.
5. How Delta Lloyd uses the Business Networking Game

Introduction

RSM Erasmus University started working on a network experiment model to fuel their research on business networks: the Business Networking Game. It is a multi-player computer-based management game that simulates the complex dynamics of business networks.

Participants play the role of an organizational decision-maker of a simulated firm and have the assignment that he/she should try to be the most profitable firm in the network in terms of margin and net income. The network experiments are built in such a way that bridging positions are beneficial for firm performance. Participants have to find out about the value of bridging positions.

The game lets players, both students of business administration as well as business managers, experience how the trend of mass customization and product personalization changes stable business networks into dynamic networks. The game aims to encourage business managers to start strategizing the opportunities and threats within their own changing business network environment.

In this article we explore the game and how Delta Lloyd have used it in their development efforts of high-potentials managers.

The Need for Gaming-Simulation

The move towards dynamic business networks demands from its members – the individual organizations – a clear strategy on how to survive the

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Stable business networks consist of a stable set of organizations that collectively produce and deliver goods and services to the market. Forced by changes in customer demand (e.g., customers ask for more service and more personalized products) and the rise of enabling internet technologies, organizations have the opportunity to redesign their business networks and form new alignments with those parties that are needed to fulfill personalized customer requirements. This is called dynamic business networking: forming temporary alignments with those parties that are qualified to produce and deliver customized goods and services [1].
change, or even on how to benefit from it. Upfront there is no single clear answer and it is difficult to assess which courses of action will have which kinds of outcome. In the literature, many stress the strength of gaming-simulation (see for instance [2,3,4]). Gaming-simulation is an experiential learning method that provokes behavioral changes. Players need to analyze problems and opportunities, make decisions, implement them and interpret the feedback on these decisions. The main objective of gaming-simulation is “. . . to enhance a comprehensive understanding of complex systems and to develop learning skills” [5, p. 90].

Therefore, the Business Networking Game has been developed, which should offer a safe experimental environment to teach and test alternative courses of action. It should enhance a comprehensive understanding of the move towards more dynamic networks and how a sound strategy to cope with this move could look. In this respect, the game should serve as a decision support system to enable the thinking and decision-making of business managers, regarding their strategy, cope better with the move towards dynamic business networks.

Angelides et al. [5] classify gaming-simulation models in three ways. First, there are systematic games versus role-playing games. Systematic games focus on the structure and relations of elements within a specific system, while role-playing games focus on a particular position within a system. Second, there are specific games opposed to general games. Specific games are industry specific, while general games are not, or can be tailored to any industry. Third, there are total enterprise games versus functional games. Total enterprise games cover a wide range of disciplines (such as marketing, production, finance, etc.), while functional games focus on one particular discipline. The Business Networking Game can be classified as a general, role-playing game, focusing on the total enterprise.

The game essentially serves two specific aims: (1) to support the teaching of students on how dynamic networks will arise and what kind of strategies can be developed to win in a dynamic network; and (2) to provide a safe learning environment to business managers in order for them to experiment with those strategies.
Delta Lloyd case: Capturing the Dynamics of the Insurance Industry

The Business Networking Game can be tailored to a specific context. RSM has partnered with Delta Lloyd Group to create a gaming simulation scenario for the insurance industry. This is an exemplary industry where business networks are changing and in which firms are struggling with maintaining and/or expanding their network positions [6]. The industry is facing the trend of customization and therefore it is collectively developing ICT standards. This will enable the ability to form quick temporary alignments within the dynamic network. A second trend is the move towards modular product architectures. The primary process of the production and sale of an insurance policy involves 5 generic activities: advice, sales and marketing, customer acceptation, claims settlement and customer service. By standardizing, especially the processes that are involved in the customer acceptation and claims settlement activities, it becomes possible to achieve economies of scale and re-use these processes for more than one type of insurance policy. The back offices of the insurance firms are increasingly more standardized, insurance professionals refer to their back offices as ‘policy factories’. These two trends illustrate how a business network changes and therefore this industry is an accurate setting for the Business Networking Game.

In Practice: Managing a Firm in the Business Network Game

We have simplified the firms in our network experiments. Each firm possesses two or three capabilities depending on its role in the business network. A customer market generates demand for insurance policies: this demand is defined as a specific set of capabilities. An order is awarded to a participant (i.e. one of the firms in the business network) if this participant firm can produce the required set of capabilities either by producing the set of capabilities itself, or by having access to such capabilities through its relationships in the business network (or a combination of firm capabilities and partner capabilities). None of the firms possesses the required capabilities to produce these insurance policies independently: they need to produce these policies jointly by way of establishing a relationship. Therefore, each firm needs to invest in a portfolio of interfirm relationships to access the required capabilities in the network. Once a firm has access to the ca-
pabilities that constitute an insurance policy then it will start receiving or-
ders for that particular insurance policy and its profit will increase.
Each firm can also decide to invest in new capabilities or to specialize in
existing capabilities. So three investment (and divestment) decisions im-
pact if a participant firm will do better than others in the game: invest in /
or divest interfirm relationships, invest in new capabilities, or invest in
specializing existing capabilities, or divest existing capabilities. In essence,
the two main levers to increase the financial performance of a firm are ei-
ther to invest / divest in new interfirm relationships or to invest / divest in
capabilities.

Figure 1 illustrates the business network and the investment options to start
or terminate a relationship. This screen, visualizing the network, is used to
invest or divest interfirm relationships by clicking on the node with whom
wants to connect. In addition, players are continually updated on their per-
formance. Finally, players are given an overall view of the performance of
their firm (figure 2).

Figure 1 Screenshot network experiment investing in relationships
Strategies to increase firm performance

To give the participants some guidance in the actions to take, we have developed three distinct strategies. We use three strategies as defined by Treacy & Wiersema (1993) to assist participants in deciding how to run their simulated firm. Treacy & Wiersema (1993: 84) propose that organizations that have taken leadership positions within their industries or business networks have focused on “… delivering superior customer value in line with one of three value disciplines – operational excellence, customer intimacy, or product leadership”. We chose for these three strategies because they can be easily operationalized in capabilities and network positions and these three strategies are well understood by both business administration students and insurance professionals. These strategies are randomly distributed among the participants at the start of an experiment but a participant keeps the same strategy card throughout the whole session.

Operational excellence refers to providing reliable products and services to customers against competitive prices and convenience. Customer intimacy refers to the ability to meet customized demand by tailoring production to the exact requirements of individual customers or market niches. Product
leadership refers to the offering of innovative, leading-edge products and services to customers that enhance the use or application of the product or service; this should offset the value of the competitors’ products and services.

All three strategies are potentially interesting in order to increase the financial firm performance. For instance, by specializing production, a firm could become a main node within the network and be part of virtually every temporary alignment formed within the network (operational excellence). Another focus could be to approach the end-customer and act as a “network coordinator” to fulfill its customized demand by forming the right temporary alignment (customer intimacy). Yet another option could be to innovate and develop new capabilities to meet the customers’ demand for state-of-art products and services (product leadership).

These three strategies are written down on three different strategy cards and these strategy cards are randomly distributed among the participants of a network experiment.

Becoming the winner of the game is determined by which strategic option is chosen and how it is executed, and by how well these options fit the strategic decisions taken by the other players.

**Evaluation**

After the network experiments, participants’ feedback was collected for future developments. Both students and manages judged the model to be quite accurate. They acknowledge that the game indeed adequately illustrates how relatively stable business networks could move to networks that are more dynamic. Unfortunately, the students seem to be more critical regarding the actuality of the model than the managers are. A possible explanation could be that students are less aware of the current developments in the insurance industry because they do not have any working experience.

Overall, the students seem to have confidence in the validity of the results, while the managers have reservations. Students and managers agree that playing the Business Networking Game is a valid and a fun learning experience.
References


6. Adaptability in Smart Business Networks

By Javier Busquets, Juan Rodon, Jonathan Wareham

Abstract

A focal characteristic of Smart Business Networks (SBN) is their ability to adapt to the environment. However, the adaptability of business networks has received limited attention. The purpose of this paper is to employ theories of learning from the educational and organizational literature to develop a framework that defines 4 distinct types of adaptation which are a function of organizational awareness and resources employed: 1) automatic responses, 2) assimilation, 3) accommodation, 4) environmental enactment. We demonstrate these modes in case study of Multiasistencia, the focal node in a Smart Business Network. The case highlights the need for SBNs to design process and technology infrastructures that appropriately allocate limited organizational awareness and resources. Implications for the theory and management of SBN adaptability are reviewed.

Keywords: Adaptability, Smart Business Networks, Theory Building

Introduction

1. Introduction

Smart Business Networks (SBNs) are defined as networks of organizations coordinating their business processes in a manner that exhibits adaptive, agile and robust behavior [38]. Adaptability is one key element of Smart Business Networks that has received some, albeit limited, attention in the literature [15]. However, we argue that greater insight into adaptive behavior is requisite towards understanding the determinants of value creation in a Smart Business Networks. Accordingly, the aim of this analysis is to focus exclusively on SBN adaptability and explicate its various modes.

We begin this analysis by surveying the literature to develop a definition of adaptation that is relevant to SBNs, defining four discrete modes of adaptability. We then present a case study of a European SBN whose focal firm is Multiasistencia, a Spanish company that has operations in Spain, Portugal, France and the United Kingdom. The company manages a ser-
vice called “Comprehensive Claims Management Service” (CCMS) serving over 100 corporate clients such as banks, insurers and utilities that service some 9 million retail and corporate customers. Multiasistencia coordinates a network of some 11,000 trade professionals (plumbers, painters, roofers, etc.) organized in small firms that provide final repair services to individual claimants. We describe the behavior of the focal firm, Multiasistencia, and illustrate the four modes of adaptability defined. We augment this discussion by describing the socio-technical infrastructures that support and enable adaptive behavior in our focal SBN. The paper concludes with implications for the theory and management of SBNs, as well as limitations of our study and prospects for future research.

2. Literature review

Adaptability

As the focal concept of this analysis, we define adaptive behavior, or adaptability, as the relationship between an agent and its environment. The idea of adaptability is central in economics, biology, sociology, psychology, cognitive sciences, learning theory, as well as managerial and organizational sciences [13]. The relationship between an agent and its environment can assume numerous forms depending upon the underlying assumptions. Environments can be static or dynamic, and agents can be both active and passive. Agents can also accept environments as is, or they and influence or affect change in environments.

As an example, consider natural selection, where an environment can be dynamic and endogenously change, thereby selecting passive species/organizations to survive or die based on the chance fit of random mutations. This kind of metaphor has been severely criticized in the managerial discourse [25]. First, where an organizational environment in many respects is given, in many others it is socially constructed [3; 9]. Second, organizations are products of boundedly rational agency and conscious intent, which influence, affect or enact environments [25][33]. Third, organizations adapt as a rational or formal intent of organizing change both endogenously and exogenously [4; 36][31].

These conceptualizations represent two extremes; in one the environment is exogenous, immune to any influence by social action. In the other,  

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3 While we acknowledge that there may be some important implications in the choice of terminology, we use the terms adaptive behavior, and adaptability (characteristics), and adaptation (process) somewhat synonymously in this analysis.
it is a product of agency and intention. We choose a definition of adaptability that lies in the middle of this continuum, one that acknowledges the changing, exogenous nature of the environment, but also accepts the ability of agents to not only actively learn, but also influence and enact environments. We take the definition of adaptation from Jean Piaget (1896-1980) in the sense that adaptation is an active product of intelligence [26]. As such, adaptation is an activity tending towards equilibrium between an active agent and a dynamic environment [12; 26]. Adaptation, in some way, can be described by a metaphor of a dance; an ongoing process of between an intelligent agent and an environment that is both dynamic and exogenous, yet influenced or enacted by the agent.

The influence of Jean Piaget in Organizational Theory

Piaget is well known for his work in children’s evolutionary processes [27; 28] and his work on human learning and development has long been a reference for theories of organizational change and evolution [31]. Piaget defines the two basic processes of adaptation as assimilation and accommodation [26]. We posit that this Piagetian dualism (accommodation and assimilation) is central to the understanding of adaptive behavior.

Assimilation takes place when an active or intelligent agent accepts the actual state of affairs (environment) as given, and chooses a response based on an existing portfolio of actions; that is, situates the actual experience within the existing limits of behavior [12]. Accommodation takes place when the agent’s current repertoire of action is insufficient, and the intelligent agent must change the mental model to find an appropriate response to the situation, or change the parameters or limits of the problem (learning).

Many authors explicitly develop both human and social evolutionary theories with the Piagetian conceptualization [12] and apply them to social organizational learning theories [8][37]. As much of this literature embraces concepts closely related to adaptive behavior, we briefly review them in order to expand and deepen our conceptualization of adaptability.

Cyert and March [6] viewed the organization as an adaptive learning system [6], where organizations act and react to environmental changes by adapting to them. Theses actions can be successful or not, thus necessitating feed-back mechanisms to adjust behavior [32]. Organizations interact with the environment by producing outputs over which they exercise considerable control. However, outcomes represent the joint product of organizational outputs and environmental response, thereby introducing a dialectic element to the concept of organizational performance [32]. According to the literature we have reviewed, Piaget’s influence in the theory of organizational adaptation is premised upon: (1) organizational decisions and
behavior; (2) organizational learning; (3) organizational change and (4) governance.

The emphasis of organizational decisions and behavior is best represented by the work of [17] who argued that “If an organization has a repertoire of programs (rules of action), then is adaptive in the short run as far as it has procedures for selecting from its repertoire a program appropriate to each specific situation that arises… Short run adaptiveness corresponds what we ordinarily call problem-solving, where long-run adaptiveness corresponds to learning” [17]:192. March and Simon tied these two concepts, problem solving and learning, to the capacity to process information and organizational memory (where repertoires of action reside).

The emphasis on learning and knowledge can also be represented by Nonaka and Takeuchi [21] who re-interpret March and Simon’s approach of information-processing by incorporating the idea that any organization is a knowledge system [25]; that is, describing an organization that creates knowledge (or learns) by achieving problem-resolution routines (no premises changed) and actions where changes of premises are needed. Learning is also the critical aspect of Argyris and Schön’s [1] theory of single-loop and double-loop learning. Here adaptation is considered a learning process where in the first case, authors suggest that single-loop learning is designing new actions while errors occurred. Double loop-learning affects to governing organizational values. In single loop learning, we learn to maintain the field of constancy by learning to design actions that satisfy existing governing variables. “In double-loop learning, we learn to change the field of constancy itself” [1]:19. March had a similar line of logic in his concepts of exploitation and exploration [18].

The bias of change can be represented by Orton and Weick [23] who explicitly claim that “adaptability implies assimilation and accommodation to change”. Authors also link adaptability as an outcome of loose coupling systems [23].

Finally, Vickers [39], cited by Van der Heijden and Eden [37], makes a similar approach, linking adaptation with organizational governance: the executive function (effectiveness in current governing function) and the political function (modify the governing function).

Accordingly, we organize the reviewed literature on adaptation as anchored on Piaget, combined with similar streams and their relative emphasis in Table 1.

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4 Comment is ours
Table 1: Adaptation: Piaget and Beyond

<table>
<thead>
<tr>
<th>Author</th>
<th>Short Cycle</th>
<th>Long Cycle</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piaget (1950)</td>
<td>Assimilation</td>
<td>Accommodation</td>
<td>Psychological process. Focus on equilibrium</td>
</tr>
<tr>
<td>March and Simon</td>
<td>Short term adaptation or problem resolution</td>
<td>Long term adaptation or learning</td>
<td>Bias on decision-making, behavior and information processing</td>
</tr>
<tr>
<td>Argyris and Schón</td>
<td>Single Loop Learning, learning from mistakes</td>
<td>Double Loop Learning Change of governing values</td>
<td>Bias on organizational learning and Knowledge</td>
</tr>
<tr>
<td>March (1991)</td>
<td>Exploitation</td>
<td>Exploration</td>
<td>Bias on Organizational Change</td>
</tr>
<tr>
<td>Orton and Weick</td>
<td>Assimilation to change</td>
<td>Accommodation to change</td>
<td>Bias on organizational Change</td>
</tr>
<tr>
<td>Vickers (1965)</td>
<td>Executive function</td>
<td>Political Function</td>
<td>Bias on governance</td>
</tr>
</tbody>
</table>

**Adaptation and Adaptability in Smart Business Networks**

In the present research, we opt to define a Business Networks (BN) as a set of inter-organizational relationships between the focal actor and interdependent external actors closely linked and working cooperatively together to create value for the customer [7]. This definition recognizes the existence of a central node and the need for coordination of activities and actors in the BN. Coordination begins with the creation of the BN and has to be perpetual throughout all value creation activities. The effective operation of a business network is premised on three requirements: (1) the effective management and implementation of key business processes, (2) the effective communication and coordination between firms in the network, and (3) the creation of an effective interface between the network and its environment [38]. Accordingly, these actions are realized through an infrastructure of business processes and information and communication technologies.

Discourse concerning Smart Business Networks (SBN) is nascent. However, authors have identified salient characteristics of successful SBNs, such as: (1) each participant increases its own value, (2) there are compatible goals among participants; (3) sustainable over time as a network, (4) generate more profitable outcomes other than other forms of competitive, or cooperative, strategy, (5) interacting in novel ways, and (6) establishing a common understanding of ethics, meanings and symbols [38].
Adaptation stems from the need to coordinate the activities of the firms in a business network [11]. The authors distinguish between two types of adaptation: 1) technical adaptations in the product features or in the production process; and 2) mutual adaptations that bind the companies together, often in a direct physical sense, and reflect the mutual commitment that at the same time constraints and empowers the companies [11]. These authors also suggest that the more integration between systems the more intra-organizational adaptation [11]. Accordingly, the more integrated information systems between organizations that underlie a business networks, the more “Internal Network” kind of organization [13].

According to Orton and Weick [23], the meaning of adaptation is integration, and adaptability implies assimilation and accommodation to change. Consequently, SBNs may provide business integration and, at the same time, the capability to accommodate to changes. In other words, networks may provide both loose and tight coupled mechanisms if we want the business network members to obtain adaptation and adaptability at the same time, that is, an organic network type of organization [4] that (1) allow interaction and integration between firms; (2) able to build loose coupled systems which are the source of adaptability [23]; (3) capable to allow organizational learning [14]; and (4) adapt to the environment while produce the environment. In other words, SBNs need to be able to manage the process of innovation between two extremes: mechanistic and organic ways of organizing [4]. One does not preclude the other. However, the critical factor is the amount of resources required to enact organic adaptation. It is sub-optimal to approach well defined problems with excessive resources that would normally be used in a process of accommodation. Likewise, approaching problems of accommodation with insufficient effort will be unsuccessful. The challenge is to recognize the difference between the two and respond with the appropriate responses and resources.

3. An Adaptability Framework

In previous sections we have covered the literature on adaptation and adaptability, importing concepts of Jean Piaget, showing his influence in the organizational literature. Adaptability is composed of two main modes, assimilation and accommodation, with biases on learning, decision-making, change and governance. Moreover, we have extended this logic by suggesting that a third mode, environmental enactment, is warranted [41][32], where organizations exert substantial resources to affect or change environmental conditions. Finally, we also think that there is space
for one more mode of adaptability: automatic responses in processes and systems programmed between the organization and environment [43]. Here we consider organizational interaction with the environment as described by the cybernetic approach [20][35], or Simon’s theory of recipes [32].

Accordingly, we propose a novel framework defining adaptability based on four modes:

1. **Automatic responses.** We can find automatic responses in living organisms. Examples are the adaptation of our iris to changes in light intensity, or increases in pulse rates when we do exercise. This metaphor also applies in the information systems and organizations. Like a software application acting according to programmed limits of action. For example, a request for service or information that triggers an expected and deterministic response of the system or organization.

2. **Assimilation,** carried out by the combination of human processes and information systems to carry on with the “business as usual” actions and behavior.

3. **Accommodation,** carried out by *informationed* people, that is, people using information to monitor the processes and to use abstract reasoning to come up with new solutions for problems or exceptions of a particular business environment.

4. **Environment enactment and innovation.** People and technology that create new conditions or new domains of action [36]. This concept is also developed by Weick [41], “managers construct, rearrange, single-out and demolish many “objective” features of the environment”5.

From our perspective, adaptation is the result of an ongoing process which is a governing function based on awareness and use of resources. First, awareness is the variable that governs knowledge requirements. Low awareness may suggest automatic responses and tacit activities [29] performed in planned or “business a usual” modes, while high awareness is required in un-planned and novel activities [22]. From knowledge theory, increased awareness is linked with learning processes based on explicit knowledge [29; 30].

Second, use of resources may enable or constrain the scale of adaptation or organizational change [16; 22; 25]. We stress that in any process

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5 This quote is taken from Scott (2003, pp. 141-145) where more detailed literature review can be found about this topic.
where decisions and political influences should be taken into account, management needs to concentrate or “knowing what they are doing” [41]. Planned and unplanned actions for large scale adaptation or change [22] require greater organizational “energy” (paraphrasing Piaget) or resources. Accordingly, our approach to adaptability can be synthesized in figure 1.

![Figure 1: The four modes of adaptability](image)

As depicted in figure 1, the primary antecedents of adaptability modes are organizational awareness and resources invested. By definition, automatic responses require fewer resources and less awareness of the agent or organization. However, the subsequent modes require higher levels. Assimilation and accommodation require greater levels of awareness and resources as responses range from “business as usual” to problem and response re-definition. Finally, environmental enactment consumes the maximum resources and awareness, as the organization not only redefines the problem scope, but also influences and defines the problem context or domain. Implicit in this framework is an idea of economic efficiency. One mode of adaptability is not superior to another. Rather, each maintains its specific function, its own relative costs and benefits, which are dependant on context and need.
4. Research Method

We now turn to the case study of Multiasistencia, a focal firm of a Smart Business Network where we will examine the processes of adaptation. Multiasistencia was in 2005 a €120m Spanish firm in the bank assurance and home repairs sector. After an introduction into the SBN’s overall history and context, we will describe how Multiasistencia characterizes the four modes of adaptability previously defined.

Given the exploratory nature of the case, we have employed a qualitative approach [10], applying a case study method [42]. Data collection was focused on the events, decisions, changes and roles in the SBN during the period 1999-2005. The following sources of information were used to prepare the case: (1) Press releases and cuttings from 1998 to 2004 in Spanish, French and English media; (2) Multiasistencia Magazine for its network of professionals and clients (2004); (3) Internal company documentation, internal communications, reports, description of processes and documentation of the software developed; (4) Financial documentation of the company; (5) Interviews with: 5 company executives, these interviews were carried out over three days in June 2004, and three days in February 2005; managers from two of Multiasistencia’s main corporate clients; two of the managers of the franchised repair companies in February 2005. The average duration of each interview was 2-3 hours. The first author also employed an ethnographic approach by spending several weeks in the company, doing field observation of the Control Center and interviews with CSRs and supervisors in June 2004 and February 2005, as well as participating in corporate client and trade professional conventions. In addition, we prepared and conducted annual focus groups with firm’s senior management and board of directors from 2004 to 2006, allowing them to corroborate and release the case data.

5. Multiasistencia

Multiasistencia was founded in Spain in the early 1980s with the intent of creating a “Comprehensive Claims Management Service” (CCMS). The service standardized the highly fragmented and heterogeneous household repairs field, applying pre-defined prices, transparent conditions, establishing service performance and quality guarantees, ensuring time response (24 hours and 3 hours for emergencies) and warranting the work for 6 months. The CCMS was offered either as part of a fully comprehensive household insurance policy or as a customer loyalty service in Spain, Por-
tugal the UK and France. The group attends to its users from an International Control and Coordination Center located in the outskirts of Madrid. The Customers Service Representatives (CSR) received customer’s calls and deployed jobs to a Network of Trade Professionals. Service quality was a key feature of the firm’s corporate culture. Multiasistencia’s commitment was reflected in its slogan: “Yes, we can”.

The Customer Service Representatives (CSRs) were coordinators of the repairs management process who engage in the reception of home repair job requests and deploy repair jobs to the appropriate affiliated trade professional. Multiasistencia was very successful in managing collectives and attracting corporate clients like banks and insurers in the 90s. In the year 2000, the firm experienced a problem of declining quality as a symptom of a non-scalable operating model. A new executive who joined the firm radically changed the firm’s operating model, previously based on telephone calls and placing Multiasistencia on the Internet. The firm applied re-engineering concepts and used ICTs to build up a ubiquitous application based on Contact Centers, the Internet, Web Services and Mobile Systems [5]. The re-engineering process took three years (2000-2003). As a result of the process, the firm’s productivity rose by 49.5% and a new SBN structure was designed. Since 2000, the Control Center manages the process, monitors the jobs in process and executes quality assurance tasks. The Control Center had, in 2005, 375 CSRs who manage over 25,000 incoming and outgoing calls a day from the different countries in which Multiasistencia offers its services. In figure 2, we show a schema of the relationship model and the main process managed by Multiasistencia.
The new repair service process consisted of four phases: opening, assignment, control of exceptions, and closing and invoicing (see Table 2).

I. Automatic Responses

The opportunities to use information technology to automate the process of managing the contacts with corporate clients and end customers by electronic means were explored in the re-engineering project (2000-2003). The objectives were; a) to ensure the control and continuity of the process, and b) to ensure its scalability and to provide it with tools for the management of peaks in demand and exceptions. According to one executive of Multiasistencia, “We have substituted all human communicative elements in the repair service, except the incoming calls, by machines. We develop a sophisticated process supported by ICT allowing people to manage exceptions”.

When the Control Center receives a call (or e-mail or fax), a CSR assesses the request for repairing. The Control Center also has a Computer-Telephone Integration Application (CTI). This interconnection allows the automatic identification of the end customer and the information related to
his or her policy which is subsequently presented to the CSR. After this point, the deployment and closing of the repair is carried out automatically. The assignment phase (see Table 2) uses an assignment algorithm, which takes into account up to 10 variables such as: place, zip code, professional specialty, insurance coverage or response time required. The deployment request is received immediately by any of the electronic channels available; the Internet or the Mobile Web Portal.

The professional can pull the job request through the Internet Portal or the Mobile Portal as well. On ending the repair, the trade professional reports the completion of the service and his new availability. Also the trade professional needs to inform the system about the costs incurred in the repair using a standard price table with some 220 variables, or the standard price list placed on the Internet Portal. This action automatically closes the repair process. Automatic electronic invoicing of the closed orders takes place from the trade professional to Multiasistencia and from Multiasistencia to the corporate clients as long as the repair is covered by the insurance policy contracted by the end customer. If the repair is not covered by the insurance, the professional issues the invoice directly to the end customer.
<table>
<thead>
<tr>
<th>Phase</th>
<th>Opening</th>
<th>Assignment</th>
<th>Control of exceptions</th>
<th>Closing &amp; Invoicing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Receipt of the repair request</td>
<td>The trade professionals are searched and assigned a repair</td>
<td>Every time an action deviates from the pattern of behavior, the Control Center accommodates actions to steer the exception to the SLA</td>
<td>Close the repair service and start the invoicing (from trade professional to Multiasistencia and from Multiasistencia to the corporate clients)</td>
</tr>
<tr>
<td>ICT (since 2000)</td>
<td>Telephone, e-mail, the Internet, SMS</td>
<td>Web portal, e-mail, SMS, cell phone portal</td>
<td>If the system does not receive a confirmation or if a complaint occurs because of quality, an exception is created and a CSR manages and follows up the complaint until it is resolved. Technology used: web services, SMS, cell phone portal, telephone</td>
<td>Cell phone portal, e-mail, SMS, web portal, web services</td>
</tr>
<tr>
<td>Changes in ICTs and their use</td>
<td>Integration of the multiple channels (phone, email, fax, etc)</td>
<td>The assignment of the repair order to a trade professional is carried out automatically using a computer application. The trade professionals can receive a message on their cell phones or via e-mail (push), or go to the website and look for a new repair (pull). Before 2000, only push, after 2000, basically pull and sometimes push (in the case of emergencies)</td>
<td>Web services, SMS, mobile portal, telephone</td>
<td>Multiasistencia automatically generates the electronic invoicing in accordance with a table of pre-established prices</td>
</tr>
</tbody>
</table>
II. Assimilation

The new Control Center integrates communication media like e-mail, mobile communications, SMS messages and Internet access. When the Control Center receives the call (or e-mail or fax), a CSR assesses the repair according to thefirm’s schema and Multiasistencia can assimilate the claim within (1) the defined framework or pattern of behavior and (2) with the committed Service Level Agreement (SLA’s). Using this new system, once a repair order is open, no one needs to intervene unless an exception occurs. One executive explained that, “With the automation process, the number of errors and incidents in the process has dropped drastically. The number of telephone calls made from Multiasistencia has dropped from 10 to 1 and the back-office costs have gone down 66%”

The results of automation have been (1) to have more control and continuity of the process (2) setting a framework or pattern of expected behavior, (3) have clean information flows between Multiasistencia and the other organizations in the network and (4) have more information. Corporate clients can exploit information [18] by having access to the same information as any Multiasistencia CSR for any direct management with their client or to complement their own corporate systems.

Corporate clients can likewise make enquiries in real time through their personalized Internet portal and cross-reference information from its contact channels, its corporate claim management system, and from external sources with the aim of providing benchmarking against averages for the sector. In particular, comparative information can be offered on the number of incidents open and their state, type of opening indices by type of clients, causes of repudiations by geographic area, invoicing details by claims, average costs or invoicing amounts. As one Multiasistencia executive added,

“Information management is a key element in our business and in the relations that we maintain with our clients has provided us with great credibility in the face of our clients. It is, however, all the more important to ensure that the data that we handle are correct and that we can have them when we need them. This is one of our priorities when making information technology investments.”

III. Accommodation

Within the case, accommodation has taken place in: (1) the international expansion of the firm; (2) the re-engineering process affecting to the claim management process and the trade professional network; (3) the new structure of the trade professional network. The existing processes of automatic responses and assimilation provide additional information, thereby releasing resources to accommodate new requirements, exceptions and innova-
tion with much more agility. Furthermore, customer-centric innovation [40] is part of the new identity of Multiasistencia.

First, Multiasistencia opened its United Kingdom headquarters in London’s Docklands with 100 employees initially, including a small call center. Operations started in January, 1997. In the beginning, as one executive explained “We tried to impose our model in the UK, but we needed to adapt it to the particular market needs. They weren’t at all interested in the CCMS. They were much more interested in getting a bolt-on claims management service. As a matter of fact, we offered repair services through our trade professional network.” Critical mass was another big issue since in UK Multiasistencia started its operations from scratch.

Multiasistencia learned from this experience and redeployed its international strategy in France in late 1996. The firm developed a join-venture with a French leading construction and public works insurer which had immediate credibility in the French insurance market, opening doors to major insurers rapidly gaining the critical mass to carry on its operations. One year after operations started, Multiasistance France handled 60,000 repairs.

Second, the re-engineering process affected the CCMS (claim process) and also to the functions and organization of the Control Center which had to accommodate to the capacity constraints imposed by the growth in demand. The organization of the Control Center is based on two teams: the “front office” is in charge of managing business as usual (our definition of assimilate) and the “back office” in charge of the whole repair process. The front office CSRs, by receiving incoming calls, proceed to open the repair process. The rest is automatic (see previous section): assigning the job to the appropriate trade professional and close the repair.

In short, “Our CSRs do not attend telephonic calls- states one Multiasistencia executive-“they manage the repair process as owners, being responsible for predictive control of quality”. To that matter, CSRs manage more information as a result of the automation process since they have to understand the whole process (Zuboff, 1988) and have the ability to steer resources and information to turn on track any deviation working more creatively generating information based on their accumulated experience or knowledge [24]. In this sense, the multiasitencia exhibits accommodation. The CSRs control a process as a combination of automatic responses, and business as usual processes (the system provides real time measurement of some 100 variables within the process), in addition to the active monitoring and response to deviations and redefinitions of standard operating practices.

Therefore, the processes now placed under automatic responses and assimilation generate additional information that enable higher levels of
awareness, releasing additional resources that permit the CSRs to have a greater decision-making capacity and a higher level of responsibility. As an example, trade professionals have an agreed time from when the job request is assigned in the system. When the trade professional reaches the end customer’s home, he reports this through a Mobile Portal or by sending an SMS. All this information is followed up in real time in Multiasistencia’s Control Center. If Multiasistencia does not receive confirmation of the appointment with the end customer in the pre-established period, an exception is generated, which will be dealt with by the CSR owner in charge of managing the claim until it is resolved.

Finally, after 2000, the network of trade professionals had to accommodate to the new schema. Multiasistencia assured trade professionals much higher volumes of work and asked them for more exclusive contracts and to increase their use of information technology. Indeed, in order to be able to manage the new volumes that Multiasistencia wished to spread among its members, the independent professional model had to be changed to small companies with a sufficient number of professionals to deal with this demand in the contractually determined times. Multiasistencia advised them on forming a business that could fulfill the requirements that they set. This change has resulted in most of the companies of trade professionals that work with Multiasistencia being franchised. These new franchises are connected in real time through Internet, Web Services and mobile systems. The new organizational ties that conforms the trade professional’s network structure are more hierarchical than market-oriented.

IV. Environmental Enactment and Innovation

Environmental enactment refers to the creation of new domains of action [36], that is the creation of new markets, services delivered and customers. One of the things that have changed the most is the new model of relationships with corporate customers. The process of environmental enactment in Multiassistencia is best described as a movement from providing a cost-effective service to becoming the reference of complex process-implementation company. According to one of the Multiasistencia’s managers

“We have developed three key skills: front office capability, the management of very diverse networks and a powerful and seamless process based on the Internet. Taking advantage of these skills, we want to become the “processes factory” for our corporate clients, guaranteeing them speed and quality. We also have plans to develop new market opportunities.”
Multiasistencia is now in charge for some corporate clients to design and manage complex processes like mortgages, or changes of customer information from one branch to another. Multiasistencia is now penetrating in the healthcare and automotive repair sectors. Furthermore, the firm is starting to orchestrate information from different agencies in local government, providing a unique point of contact to citizens in different cities.

The firm’s new capabilities are a new and unique way to combine people and technology to fulfill (adapt) to new market needs and requirements, particularly liberating people and informational resources from the day-to-day operations to create new scenarios and new knowledge for develop economies of growth [25] demonstrating a network operating system that is scalable, but also adaptable showing a self-renewal behavior [38].

In addition, Multiasistencia has boosted innovation (creating new services) by collaborating with its corporate clients [40] creating a network for innovation. As one executive added “The 80% of our software developments have been done in collaboration with our corporate clients”.

First, the firm offers custom-designed services that include a complete range of features, such as comprehensive management of repairable or cash settlement claims, the provision of customer care help-lines, the management of networks of loss-adjusters and the management of recoveries (negotiated or through a judiciary process). Second, Multiasistencia has introduced innovations in the process: digitalized signature and electronic invoicing, which have increased savings up to 40%. Third, the creation of new services based on information like the management of claims adjuster reports on behalf of insurance companies. One manager added,

“When the repair assessment goes below an economic threshold, loss adjusters can carry out a “desk-top audit” on the Internet with the digital photographs our trade professionals take in customer houses. In the first tests carried out with the new system, the inspection cost has been reduced by 60%.”.

And finally, in 2005, one of the largest insurance companies in Europe and Multiasistencia collaborated to define a new service to inform end customers about the process whenever a claim was presented. The application sends Short Message Services (SMS) messages through cell phones to the end customers. As one of the insurer’s executive explains,

“We inform our customers of every step we follow when he or she presents a claim and until the claim is closed. In order to ensure loyalty when the service is used, we not only have to satisfy quality expectations, but we
also have to inform the customer. We have to add transparency to our service. Information is the key to increase loyalty.”

6. Discussion

Multiasistencia’s management decided in 2000 to change the network process, the business relationships and used ICTs as an element of integration. According to one executive, “In short, what defined our project was placing the process on the Internet.” Multiasistencia built the capacity to accommodate changes, that is, adaptability. Table 3 presents the 4 modes of adaptation, describing the Multiassitencia cases and ICT enablers.
Table 3: The four modes of adaptability in Multiasistencia

<table>
<thead>
<tr>
<th>Adaptability Modes</th>
<th>Multiasistencia Processes</th>
<th>ICT Enablers</th>
</tr>
</thead>
</table>
| I. Automatic Responses | - Assignment of jobs to appropriate trade professional  
- Automatic Invoices  
- On line quotations of repairs  
- Claim closing | - Internet  
- Web Services  
- Mobile Portal  
- Mobile System |
| II. Assimilation | - Claim opening and life cycle management  
- Exploitation of Information | - Call Center  
- Integration with corporate clients call centers  
- On line analytical services (DataWarehouse) |
| III. Accommodation | - New Markets Accommodation  
- Re-engineering processes  
- Ad-hoc services and exception management (service improvements)  
- New structure of Network of Professionals | - Dynamic control (and alarms) procedure of behavior  
- “Decentralized” control (100 points of control)  
- Internet / Web Services integration with corporate clients and trade professionals |
| IV. Environmental Enactment and Innovation | - Opening of new geographical markets  
- Customer-centric innovation on new services (Exploration of Information)  
- Defining new markets as Healthcare and Public Sector. | - “Factory of Processes” (System renewal)  
- Real Time System Integration with different agencies |

To this aim, Multiasistencia has developed a new network operating system that allows the focal firm to manage adaptation among participants, structuring and integrating information among nodes and links, allowing firms to establish compatible goals. In other terms, the new information system spread out in the network has helped to establish structured and institutionalized patterns of behavior (Tsai & Kulduff, 2003) [32]. This behavior is so highly embedded in the systems and processes that it is “diffi-
Adaptability in Smart Business Networks

cult to identify where the real smartness resides” [38], since “the system” is a combination of people and machines, that is, a cybernetic system [20]. Therefore, the system (1) tracks environmental variables [32] and, (2) shows dynamic self-regulating and self-organizing behavior [38] allowing Multiasistencia to dynamically adapt to the environmental conditions with the four modes exposed in this paper, and (3) creates an image of the environment where the action occurs. By automating and releasing resources, Multiasistencia generates more information (Zuboff, 1988), through which it can assimilate information from the environment and run business as usual. This information allows the firm to develop new solutions and services (Factory of Processes) based on informational exploration [18], that is, accommodating new requirements. As one the executives indicated,

“Our model is that of making the whole process transparent. The integration of processes on the Internet has allowed us to define a “virtual machine of finite states” with very precise expiry dates between states. The application has about 100 controlled steps linked to our client and professional applications. When an exception occurs, we must offer all the information available to the person directly responsible for its management to make the decision-making more effective.

Assimilation and automatic responses include the structure for running “business as usual” tasks such as claim opening, automatic job assignment and claim closing. These two modes are related to the exploitative use of ICT [18]. This use of structured information deals with the single-loop learning process [2] or the problem resolution [17]. Adding more experience to people running the business, and facilitating a learning process of the day-to-day activities results in knowledge interiorization and socialization [34]. On the other hand, as a result of more information, Multiasistencia has developed explorative uses of ICT that deal with new services development (i.e. virtual, remote surveyor’s inspection), process development (i.e. better task planning) and customer development (i.e. from new customer acquisition to changed interaction patterns) tasks.

We consider that incremental innovation is performed in collaboration with corporate clients (e.g. tele-surveys, SMS customer information, etc.), more radical innovation can be found in the accommodative processes (ad-hoc services, re-engineering) or creating new markets or conditions.

Information technology has played a fundamental role in redefining the type of professional that Multiasistencia manages. The Franchise Internet Portal for professionals contains the same information as that available for a CSR from the Control Center with the capacity to carry out 100% of the transactions defined by Multiasistencia. The system assures payments and has reduced the paperwork which represented around the 50% of working
time on estimating, invoicing and collecting of money’s owed by corporate clients end customers. For those franchises that already have their own applications, the essential part of the functionality offered by Multiasistencia is available in Web Service technology. Adoption levels have grown from the 10% PC penetration in the year 2000 to over 95%. In the case of mobile telephony, the vast majority have adopted the Multiasistencia service offering because of its convenience and good service prices.

Contributions to Theory

As mentioned previously, key characteristics of Smart Business Networks (SBN) are their ability to exhibit adaptive, agile and robust behavior [38]. However, adaptive behavior in the context of business networks has received limited attention. Our analysis has synthesized diverse theories from learning to delineate 4 distinct modes of adaptive behavior. Adaptability and its four modes are a function of awareness and resources. Automatic responses and assimilation require limited awareness and resources, where accommodation and environmental enactment demand significantly greater resources. So the key message is that adaptability in business as usual environments require low awareness and low resources; exploiting the use of existing technology infrastructures and repertoires of processes or programs [17] combined with tacit collective knowledge [34]. In contrast, accommodation and environmental enactment, exception handling, agile responses to undefined problems, or defining new domains of action [36], require higher levels of awareness and resources to develop conscious and explicit managerial knowledge [34]. In short, learning is a costly activity.

These observations are important for several reasons. First, there has been no shortage in the literature professing the merits of innovation, exploration and or other forms of long cycle learning. Our analysis highlights the fact that while these capabilities are admirable, they are not always the most appropriate for the set of tasks or problems. Short cycle assimilation and automatic response are equally important in operations of any organization and network.

Moreover, our analysis also suggests that long-cycle learning modes have high costs in terms of organizational cognition and resources. The expenditure of limited resources on the wrong types of problems can lead to inefficient and ineffective managerial decisions. Finally, we draw attention to the interdependent nature of the adaptability modes. The appropriate placement of processes in the automatic response and assimilation modes generates important bi-products; additional information and the release of constrained organizational resources that enable accommodation and environmental enactment.
Contributions to Management

Every time management decides to develop new concepts, new services, new spaces, they explicitly expend additional resources. Management is then an exercise of defining limits for appropriate organizational responses; that is automatic responses (machines help with automatic limits programmed by humans), assimilation (combinations of well defined human-machine decision making), actively modifying them to new sets of action (accommodation) or defining and enacting new environments. By managing information and knowledge to accommodate new situations, innovate products and services, and invent new domains of action, managers can ensure high levels of innovation as one of the core competences of the firm. However, it is important to carefully delineate between tasks requiring: 1) automatic responses, 2) assimilation, 3) accommodation, and 4) environmental enactment, such that managers can design processes and technology infrastructures that appropriately allocate limited organizational awareness and resources.

Limitations

As with all studies, this analysis has several limitations that warrant attention. First, all research on networks suffers from the difficulty of delineating the unit of analysis, where in networks, many levels of analysis are entwined [13; 19]. Secondly, we have appropriated theories with their genesis in individual learning and applied them towards organizations and networks with little consideration for how the theories become more or less adequate as we transgress levels of analysis. While we suggest that this contribution is novel, we also recognize that future research should consider the coordination and learning mechanisms that govern network behavior and their differences from other units of analysis. Namely, are models of individual or organizational cognition appropriate to study networks? If not, what modifications or other theoretical foundations are more applicable. Moreover, we specify awareness and organizational resources as the main antecedents of adaptation modes. However, this classification is fairly broad. Understanding the types of resources consumed at different levels of adaptation is also worthy of additional attention. Finally, the normal caveats of case study analysis also apply to this study. We have used this case in order to synthesize divergent theories of learning to explore a poorly understood, yet important characteristic of smart business networks. Additional qualification and validation across larger samples is obvious in a larger research agenda.
7. Conclusions

Where adaptability has been noted as a key characteristic of successful Smart Business Networks, the concept remains poorly understood. Accordingly, this paper employs theories of learning from the educational and organizational literature to develop a framework that defines 4 distinct types of adaptation in Smart Business Networks. Adaptation is a function of organizational awareness and resources employed and is defined as: 1) automatic responses, 2) assimilation, 3) accommodation, and 4) environmental enactment. Where automatic responses and assimilation represent business as usual, accommodation and environment enactment place greater demands on organizational cognition, requiring additional resources. We demonstrate these modes in case study of Multiasistencia, the focal node in a Smart Business Network. The case highlights the need for SBNs to design information and process infrastructures that appropriately allocate limited organizational awareness and resources to the right kinds of tasks and processes to optimize the process of adaptation in Smart Business Networks.

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7. Electronic Intermediaries in Smart Business Networks

By Amit Basu and Steve Muylle

Abstract

This paper examines the role of an Electronic Intermediary (EIM) in coordinating business processes in a Smart Business Network (SBN). A conceptual model is presented that links EIM business model, EIM evolutionary context, and EIM service scope to business performance, and generates insight into the coordination role of the EIM. The model is illustrated through its application to a set of EIMs in various geographies, across a two-year time frame. Also, the coordination role of an EIM is considered within its broader governance context.

Keywords: electronic intermediaries, coordination

1. Introduction

Electronic intermediaries (EIM) are organizations that provide online services that enable other organizations to interact with each other in business processes. EIMs are increasingly challenging traditional value chains. By connecting multiple organizations into networks in which members link and interact to achieve highly efficient and effective service delivery, EIMs are becoming a common and valuable part of many smart business networks (SBNs) [20], that leverage capabilities of members for competitive advantage.

Much of the existing research in the area of electronic intermediation has focused on electronic marketplaces [13]. However, EIMs can offer a variety of services other than market making. It can be argued that EIMs stimulate new roles in which participants transact, collaborate, and integrate, coordinated by an “electronic hand” (as opposed to Adam Smith’s [18] notion of an “invisible hand” guiding the process of buyer-seller matching though price discovery). However, academic research in this area has been very sparse to date, and has often taken a very narrow perspective on such mechanisms. In particular, the notion of an EIM assuming
roles other than that of market maker and/or online exchange has not received much attention in the literature.

The objective of this paper is to examine how an EIM can coordinate business processes within an SBN. Toward that end, we present a conceptual model that ties together three dimensions of EIMs: the business model adopted by the EIM, the evolutionary context of the EIM, and the scope of the EIM in terms of its online service and process support. By identifying a suitable business model and choosing online services that are consistent with its business model and its evolutionary context, the EIM can coordinate business processes in the SBN and enhance its business performance. We illustrate the conceptual model with some specific patterns of activity and support that it would imply, and then examine the extent to which these patterns are observed in practice, based on data from a small set of EIMs. We also consider the implications of the role an EIM can play in the governance of an SBN.

The paper is organized in five sections. In section 2, we review the relevant literature on EIMs and business networks. In section 3, we present our conceptual model. In section 4, we illustrate the model with data from a set of case studies of actual EIMs, and finally, in section 5, we discuss the implications of our model for coordination and governance of activities within SBNs, and identify further research opportunities.

2. Literature Review

Three streams of literature on the design of EIMs are related to the approach presented in this paper. The first is the literature on electronic business models, the second includes research on electronic business services provided by EIMs, and the third examines the evolutionary context of an EIM.

2.1. Electronic Business Models and Services

A business model is defined as the set of services and processes a firm offers to its customers while electronic business services are defined as a set of logically related activities performed to achieve an intangible business outcome through the adoption of Internet technology. A typology of e-business services is presented in Mylly and Basu [14]. This integrative typology is grounded in the e-business model literature (e.g., [1]), the electronic intermediary literature (e.g., [6, 17]), and conceptual research on electronic business architectures (e.g., [3, 8, 19]). Transaction, decision support, and integration services are distinguished as potential services a
firm can offer to its customers as part of its electronic business model, and a comprehensive typology of electronic business models is presented (see Table 1). The concurrent consideration of business model and service support allows a firm to plan its online services and a fit between the firm’s business model and service scope can be predicted to positively impact business performance.

**Table 1: Business Models and Service Support (from [14])**

<table>
<thead>
<tr>
<th>Business Model</th>
<th>Transaction</th>
<th>Decision Support</th>
<th>Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange</td>
<td>X</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Collaboration Hub</td>
<td>-</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>System Integrator</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Value-added Exchange</td>
<td>X</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Business Process Integrator</td>
<td>-</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Integrated Exchange</td>
<td>X</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Full Service Provider</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

While the business model literature largely concerns “principals,” namely firms that themselves want to trade through the online entity, other units of analysis can be adopted. In this paper, we focus on intermediaries (EIMs) rather than principals, employing the business models and service sets identified by Muylle and Basu [14]. However, we also consider the dimension of evolutionary context, which is not considered by Muylle and Basu [14].

### 2.2 The Evolutionary Context of an EIM

Given the short history of EIMs, very few studies have studied the impact of evolutionary factors such as the origin, ownership and reach (in terms of firms that can participate in the EIM), on the business model and services that the EIM offers. One such study is by Kambil et al. [10], who argue that the emergence of different types of online market structures (as opposed to hierarchical coordination mechanisms) is influenced by structural characteristics of the industry and the needs of buyers and sellers. Another approach is presented in Kambil and van Heck [9], where the EIM’s ownership structure is used to categorize the significance of differ-
ent types of services. Other studies do not explicitly factor in business models or the EIM’s operating context when defining the level of support it should provide for various service sets.

To be brief, while each of the streams of literature reviewed in this section augments our understanding of EIMs, there is no comprehensive and intuitive framework that combines consideration of business models, service scope, and evolutionary context in planning and coordinating an EIM. The approach presented in this paper addresses this problem.

3. Conceptual Model

Our model of EIMs consists of three dimensions, linked to business performance, as shown in Figure 1. Each of the dimensions is described next, followed by a discussion of business performance.

Figure 1. EIM Conceptual Model

3.1 Service scope

In keeping with the electronic business services typology proposed by Muylle and Basu [14], the functional scope of an EIM can be characterized in terms of three categories of services.

1. **Transaction services:** Transaction services comprise the process of buying and selling online. Specific transaction services are:
- **Search:** Finding relevant entities and objects for any business transaction, and enabling sellers and buyers to locate each other to exchange goods and services.
- **Authentication:** Ensuring the authenticity of the parties involved, as well as the quality of the products and services being transacted.
- **Valuation:** Price discovery, which can be of two types: (1) fixed pricing; and (2) dynamic pricing.
- **Payment:** Paying for online purchases, with electronic payment instruments at the transaction services level.
- **Logistics:** Moving products and resources within the participating firms, including shipment and delivery of purchased products from the seller to the buyer.

2. **Decision support services:** Decision support services enable participant firms that interact with the EIM to obtain information and use analytical models that enhance their ability to make effective business decisions. These services can be supported at two levels. The first level is where the EIM enables each participant firm to better monitor and plan its own operations, independent of other firms (regardless of whether these other firms are also participants in the EIM or not). The second level is where the EIM enables multiple participant firms to interact with each other in ways that helps each of them make better decisions. Specific decision support services are:

- **Configuration:** Helping buyers define needs, including facilitating interactions between buyers and sellers to develop a product that can meet those needs.
- **Collaboration:** Facilitating interactions between participant firms that support joint or collaborative work between multiple people in one or more organizations, using Web-based computer and communication technologies.
- **Business Intelligence:** Providing information about market conditions and trends, at the unit, firm, industry and overall market levels.

3. **Integration services:** Integration services help firms that participate in the EIM to integrate their information, computing and communication systems, on either an intra-firm or an inter-firm basis. Through these services the EIM enables automation of business processes across the boundaries of different component information systems. Although intra-firm integration can sometimes be facilitated by an EIM, the most likely utilization of the integration services of an EIM is across participant firms. Specific integration services include:
• **Data Integration**: Enabling a firm’s software applications to access its partners’ databases regardless of the specific database structures, software and systems that each entity employs.

• **Application integration**: Using mechanisms such as Web services and eXtensible Markup Language (XML) to integrate the computer applications of different participating firms.

3.2 Business Model

A comprehensive typology of EIM business models based on the set of services offered to customers is presented in Table 1 [14]. Each of the business models is characterized by the specific service or combination of services offered by the EIM. While an EIM pursuing an exchange business model only offers transaction services, an EIM adopting a value-added exchange business model also offers decision support services. Likewise, an EIM taking on a business process integrator business model offers both decision support and integration services. The most elaborate business model is the full service provider, which offers transaction, decision support, and integration services. It is important to note here that the business model dimension is separated from the service categories as the scope of an intermediary that uses each business model does not necessarily correspond to the union of the scope associated with the component roles [14].

3.3 Evolutionary Context

Many EIMs are pure-play intermediaries, namely firms that are independent entities with only online operations. However, it is also possible for a set of firms that have offline business relationships to set up an EIM for specific business processes spanning one or more of the major service categories discussed above. Our categorization of EIM ownership and contexts is as follows:

1. **Pure-play**: An EIM created by a firm that is a pure intermediary, with no ownership interests in any firm participating in the EIM (e.g., eBay).
2. **Closed Online Extension**: An EIM owned by one or more principals (i.e., firms that are participants in the EIM). The owners may have pre-existing relationships with each other through traditional offline interactions (e.g., CoViSint).
3. **Open Online Extension**: A hybrid of the two earlier types, set up by an initial consortium of firms, but the set of participant firms changes quite frequently (e.g., FreeMarkets).
This classification is related to that of Kambil and van Heck [9], where three categories of online exchange are considered, namely private exchanges, consortia exchanges and independent exchanges. In that approach, the primary discriminator between the alternatives was the ownership of the exchange. Our classification extends the classification to two dimensions, ownership and openness (where openness refers to support for online admittance and authentication of new participants). One category from Kambil and van Heck [9] that we do not distinguish is the private exchange, since it is essentially a closed extension with a single owner.

The context dimension is orthogonal to the business model and service dimensions. For instance, the integration of product catalogs is important for integrated exchanges and full service providers, but more so in the context of an online extension than a pure-play intermediary.

3.4 Business Performance

While business performance can be defined in financial terms (i.e., EIM profits, revenues, transaction volume), and/or organizational growth (expansion of the EIM in terms of offices, customers, employees, partners, geography, and industry), these perspective are not always appropriate in an SBN setting. Indeed, an EIM can also be evaluated in terms of value added for the participant firms that invest in the EIM. This value-add may entail member revenue increases, cost savings, and better decision making. The latter is in line with the coordination science literature (e.g., [12]) in which decision rights and their distribution are linked to firm performance. Anand and Mendelson [2], for instance, state that information technology reallocates information among decision makers and find that a fully distributed coordination structure, in which the branches make their own decisions based on local knowledge and aggregate data provided by the center, offers better absolute performance than either a centralized or decentralized coordination structure. Nault [15], however, warns that the collocation of information and decision rights, his so-called mixed mode, suffers from coordination problems that are not present in case of fully centralized or decentralized decision rights. Clearly, business performance is closely linked to coordination advantages and costs, bolstering the importance of effective coordination by EIMs in SBNs.

In keeping with Muylle and Basu [14], an EIM that clearly identifies a suitable business model and chooses services that are consistent with the business model can be expected to enhance business performance (and bring about coordination advantages). In an EIM setting, however, evolutionary context is expected to moderate the business model – service scope – business performance relationship, as shown in Figure 1. More specifically, an EIM that is pursuing a specific business model needs to consider
its evolutionary context in planning and coordinating it service scope for enhanced business performance.

4. Case Study Insights

In order to illustrate the conceptual model and examine the role of an EIM in coordinating business processes within an SBN a multiple case study research was conducted over a two-year time-frame, 2003-2005, across different geographical regions. Through a key informant approach [5], ten EIMs have been analyzed, with particular focus on identifying the e-business services they support, the business models adopted by them, and their evolutionary context. Also, business performance and the form and nexus of the coordination of the operations of the network within which they operate were considered.

The results highlight that the coordination role of the EIM not only depends on the business model it adopts and the business services it supports, but also on its evolutionary context. Given the central role of an EIM in interconnecting its various participants, it is intuitively reasonable to expect that the EIM can and should play a significant role in the creation of an orderly and robust business network, and in the formulation and implementation of appropriate governance mechanisms for the collaborative enterprise. However, the coordination role of an online extension intermediary may be different from that of a pure-play intermediary. For instance, a pure-play intermediary that uses the exchange business model has to provide extensive authentication services for both products and parties (traders). On the other hand, a closed online extension exchange may have to provide only product identity authentication, and may not have to provide any participant authentication, and little or no product quality authentication [4]. This interplay between the service scope of an EIM and the role it can play in the governance of the SBN is an important consideration for the design of effective and successful SBNs.

As proposed in Muylle and Basu [14], we find that EIMs which reconcile their business models with business service support perform well, and consistently so (as validated over the two-year time-frame in our case study set). A case in point is TradCom, an integrated exchange in the MRO market in Belgium, the Netherlands, and Luxembourg, which has reinforced its position through significant enhancements in logistics and integration. It has stayed away from decision support services, and has been very successful. Yearly transaction volume has increased from €2m to €8m with 2,100 customers, and suppliers have grown from 5 to 18 firms. In ad-
dition, suppliers enjoy revenue increases as new customers of other participant, complementary, suppliers enter the network. Likewise, Inter-Sources, a Western European value-added exchange operating across multiple industries, made major enhancements in the area of decision support, thereby enjoying significant growth in volumes from €50m to over €2b and from 2 to 15 participants, while sustaining operating profitability since Q4 2003.

Also, evolutionary context is found to be an important moderator. RubberNetwork, for instance, positioned itself as an open extension integrated exchange in the global tire and rubber industry, but its activities more reflect a closed extension (no new partners are sought or invited). Also, this EIM is enhancing its decision support services because of owner demands in view of its “community benefits” charter; in effect it is functioning as a full service provider. However, its owners are mutual competitors so information sharing has to be limited to non-strategic items. The number of customers has stayed at nine, and the number of employees is down from 60 to 54. Its most significant performance benefit has been in transaction volume and cost savings in purchasing. It is questionable if this EIM would survive if it would be operating in a pure-play setting. Another case is i-Faber, an EIM which has reinforced its position as a pure-play exchange in Italy and Eastern Europe through the adding of an online scouting service which was quickly adopted by all participants. i-Faber is profitable since the second semester of 2004 with €1.1 billion in transaction volume for the year. Also, the number of buyers and suppliers shot up from, respectively, 75 and 1,200, to 200 and 5,400. A small confound, however, is that i-Faber has added integration services and has launched supply chain integration (to establish the entire procure-to-invoice cycle online) due to pressure from some large customers. It is of interest to note that, in line with Nault [15], coordination costs are incurred by both RubberNetwork and iFaber, as they collocate decision rights and information outside their evolutionary context.

5. Implications for SBN Governance

The consideration of each of these factors (business model, service scope, evolutionary context, and business performance) is important in the design of governance mechanisms for any SBN that is organized around an EIM. Indeed, consider the service scope dimension. The key responsibility of an EIM focusing on transaction services is to establish and communi-
cate the business rules for setting up and executing transactions through its online marketplace. Each participant acts in its own self interest, and therefore there is little need for the EIM operator/owner to gain visibility into the operations and processes of individual participant firms. In the case of an EIM that provides decision support services, there is a greater need for the EIM to work with the participant firms to obtain the relevant information about their operations that enable the EIM to provide meaningful and valuable business intelligence, collaboration and configuration services. Finally, an EIM that provides integration services has to gain visibility and has to coordinate not only the information flows from participants, but also their information systems and business processes, so that the appropriate end-to-end integration among participants can be achieved.

The impact of evolutionary context is also significant. For instance, the relationship between a pure-play EIM and its participants is largely an arm’s length peer relationship. On the other hand, the prime movers in an online extension (both closed and open) are often the founding participants, who establish the goals and scope of the EIM and thus set the business rules of the SBN. This includes the financial and operating goals of the EIM, and the scope of the collaborative processes within the network.

The framework presented in this paper provides valuable insights for managers of firms in SBNs that contain EIMs, whether these are participant firms or the EIMs themselves. In particular, it can help identify key questions that need to be addressed in the development of appropriate governance and evaluative mechanisms. In particular, the framework helps determine what type of governance role is consistent with its scope and role within the business network. As to the latter, an important avenue for further research is to go beyond the coordination role of EIMs and explicitly consider evaluation and control as key issues in the effective governance of an SBN. Established research on the design of control mechanisms that distinguishes between formal and informal governance mechanisms such as outcome control, process control, and clan control, can serve as focus and offer valuable insights [7, 11, 16].

References


8. Business Services as a Modeling Approach for Smart Business Networks

By J. L. C. Sanz, N. Nayak, V. Becker

1. Business Networks, Business Architectures and Business Services

While Web Services and Service-Oriented Architectures (SOA) [1] have provided some important insights on how to design plug-and-play ecosystems of enterprises based on the interaction of information systems, Smart Business Networks [2] require a richer level of abstraction. Realizing the goals of standardization, specialization, modularity and openness in intra and inter-company operations through Smart Business Networks offers a new and very appealing perspective. As it was pointed out in [2], we need a systematic way to characterize Smart Business Networks in the form of suitable concepts and language. This paper introduces the concept of Business Service-based modeling of companies and related ecosystems as an approach for attaining these goals.

Encapsulation and separation of the assembly of services from their actual implementation lie at the realm of SOA. As it is shown in the ongoing Service Component Architecture standardization effort [3], the value of SOA-approaches holds irrespective of the granularity or level of the proposed modeling. Although SOA concepts are not limited to information technology applications, modeling business networks needs to be based on a richer set of business architecture abstractions that go beyond providing service construction and assembly.

A seminal paper by D. McDavid [4] has provided great insight into the main concepts and ontology toward a definition of ‘business architecture’. As McDavid has shown, there are several dimensions needed to represent the most common concerns arising in business. For example, one of such dimensions, called “Outcome”, and its relationship to “Commitment”, “Role Player” and “Purpose” provide an abstract framework to introduce the concept of Business Service, the agreement between its provider and consumer and the goals in an enterprise such a Business Service fulfills. A variation of the original scheme shown in [4] is included in Figure 1 below.
As Figure 1 shows, there are some loops around each of the business architecture dimensions, thus suggesting that each of these entities may have a dependency on one or more entities of the same nature or type. For example, a commitment has other commitments on which it builds; an outcome has other outcomes on which it depends, and so on. Since the ‘owner’ of different occurrences of the same concept can be in different enterprises, this means that company boundaries may be crossed by these ‘recursive loops’ depending on the specific dimension at play and the modeling scenario. For example, a commitment may be binding two players in different companies; an outcome may depend on outcomes provided by other companies, etc.

**Figure 1. Business Architecture Principles**

The generic principles described by the business architecture scheme of Figure 1 clearly are suggest that there are several relevant business networks inside and across enterprises, all interconnected by links with verbs that explain the semantics of these connections. In fact, the obtained well-
known Social and Organizational Networks could be cast as networks that are defined by linking resources in an extended enterprise. A key question is then which of these multiple networks is the most appropriate one. Undoubtedly, while the answer will ultimately depend on the goal of the model, the requirements posed by a Smart Business Network lead to Business Services as the most suitable architectural choice.

On the other hand, Business Processes have governed intra and inter-enterprise operational modeling for several decades and have also provided the basis for many business transformation efforts. Business Processes have become an early form of standardization for intra-company and inter-company business operations. In fact, the maturity of certain classes of Business Processes has given rise to significant outsourcing and supply-chain implementation markets that have helped companies produce substantial savings and foster innovation.

However, there is a clear need for new ways of modeling inter and intra-enterprise operations that exploit deeper levels of industry-specific commonalities across companies, thus realizing further economies of scale while yielding more cost savings, deeper innovation and enhanced resilience. Some recent approaches to modeling inter-company collaboration have been presented in [9], [10]. The ecosystem view of a network of enterprises used by Iansiti et al. [9] is definitely one of the ways a Smart Business Network can be modeled. However, the lack of a deeper model to render such Smart Business Networks models more operational still remains as an open problem. Another important approach based on the concept of componentized enterprises as introduced in [11] and [12] brings an opportunity to build the needed concepts and language enabling Smart Business Networks.

As we have stated earlier, the concept of “services” is not new. Service Oriented Architecture (SOA), related Web Services and other service standardization efforts are already well-known. Furthermore, their potential use to enable Smart Business Networks has been also shown [13]. Since an increasingly large part of the world’s GDP is based on services-based industries and related economic activities [14], the term “service” has become quite overloaded and thus, unfortunate confusions have been created, the most common one being the assumption that all Business Services of

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6 In particular, the above remarks show that the architecture of Figure 1 is not limited to a ‘company-centric’ view of business but it also encompasses an ecosystem perspective.
‘interest’ can be subjected to IT Services-based implementations\(^7\). Software tools for modeling processes by implementing SOA concepts also exist today and are available from different providers [15].

In spite of these multidimensional trends in the “services” world, known formal services operation models and their interaction in a network of enterprises have been primarily used in integration of IT systems motivated by modularity and interoperability. Thus, “services” have been used as an implementation mechanism for the realization of intra and inter-enterprise business processes [1]. These IT service models, which are targeted towards solution implementers, do not adequately address the needs of higher level, business-oriented modeling.

On the business side, companies are beginning to recognize the importance of service orientation as a pre-requisite to becoming competitive. For on demand interaction with their customers, suppliers, partners, and employees, companies are beginning to explore actively what Business Services to provide and how to develop them rapidly in order to be responsive, innovative and grow margins. Hence, there is a need for proper operational modeling constructs and corresponding SW tools that support design, representation, and analysis of services that are required by service-oriented businesses. Business Services provide a very useful paradigm for extended business-level standardization, modularity, and specialization.

Modeling a Smart Business Network with Business Services is all about choosing the right architectural entities for designing a business, an industry segment and the involved ecosystem at the right level of granularity. These are some of the key elements that make standardization feasible. On the other hand, the SOA concept per-se cannot generate the same type of industry-wide convergence toward a common business framework because most of the ‘service content’ generated has been mostly related to the IT level.

Recently, Business Services have been introduced through a rigorous Unified Services Metamodel (USM) that captures and extends the capabilities needed to model a componentized enterprise ecosystem [15]. Actually, IBM has studied an innovative way to represent entire industries by using Business Services, dubbed Component Business Modeling (CBM), thus

\(^7\) In some cases, IT Services are considered to be the only services that matter.
suggesting a very significant opportunity to foster unprecedented levels of standardization and modularity at a business-level [11], [12].

Consequently, the design of Smart Business Networks based on Business Services becomes an appealing approach since it offers an opportunity for unleashing the value of “network of enterprises” to an operational level while simultaneously deepening the degree of standardization for individual industries, industry segments, and appropriate cross-industry levels.

2. Smart Business Networks Modeling through Business Services

As we said in Section 1, enabling Smart Business Networks calls for the right level of granularity of the model of a company intervening in such a network and also requires the selection of the correct business architecture entities to be used as the primary elements of the model. A too fine granularity leads to excessive detail, as in the case of Web Services. In this situation, the desirable characteristics of a Smart Business Network [2] such as its agile ability to carry out business decisions to connect–disconnect, the possibility to effectively manage the network and finally, the capability of reasoning about matters of strategic business nature are hindered by the intricate nature of the chosen representation.

In our approach we have selected “Outcome”, or Business Service, as the main dimension to model our Smart Business Network because of several practical and fundamental reasons. First, this business architecture dimension represents exactly the main concept that exists to fulfill the business goals of an organization, business units and finer-grain operational entities. Second, a network of such architecture concept also captures the main intra-company and inter-company operational dependencies that these entities have, expressed in the form of Business Services offered to and used from the ecosystem. Finally, provisioning-based design of operations is at the core of the cost structure governing company performance and economic models of industry deconstruction. Thus, for all practical purposes, a Business Service Network is not only a generalization of the ‘supply-chain’ model but it also captures the behavior inherent to the ecosystem, as it will be shown later in the paper.
On the other hand, the choice of alternative business architecture entities could also become an insurmountable hurdle for the goals of a Smart Business Network. If purely behavioral entities are selected, such as Business Processes, the issue of lack of modularity comes to play since the main processes in an operation usually span many activities located across large sections of the resulting network. Finally, if only business rules\textsuperscript{8} are chosen as the business architecture element dictating the definition of the network, then a rich understanding of the commitments governing the interaction of the nodes will be obtained but simultaneously, the operational capabilities of each individual role player bounded by such rules will be absent from the representation.

In our approach, the representation of every enterprise participating in the Smart Business Network is given by a set of Business Services (nodes), while a directed link in the graph joining two Business Services represents the existence of a dependency of the source Business Service node on the Business Service represented by the target node (see Figure 2).

Intuitively, a Business Service is the business architecture entity that represents the outcome of a significantly large “chunk of operation” in a company. As it will be shown below, a Business Service includes specific functional forms under which it is made “visible” to the ecosystem, a high-level description of the operations it carries out\textsuperscript{9} and that include the behavior rendered by other Business Services on which it depends, and a service agreement that captures the commitments made to other network participants.

\textsuperscript{8} Business Rule is a particular case of “Commitment” in the business architecture approach discussed in Section 1.

\textsuperscript{9} The fact that a Business Service involves ‘Behavior’ as a part of its internal architecture is well-aligned with the inherently recursive ‘fractal’ nature of business architecture description presented in [4].
Thus, a Smart Business Network is depicted as a rich graph of Business Services representing the outcomes that each main organizational unit of a company offers to and needs from the network as well as the commitments that govern every interaction involving a Business Service in the network. As a byproduct of the above ideas, the ability to build multiple Smart Business Networks, support intelligent connect-disconnect, and analyze economic and strategy value provided by such a network will be facilitated by a repository in which all available Business Services can be found. This repository would also be searched through when seeking for Business Services candidates that “match” against a given Business Service specification.

It is clear that every Business Service has a single “owner”, for example, the company or business unit responsible for furnishing it to the ecosystem. We call this role-player Business Service Provider. In Figure 2, we have painted the nodes of the Smart Business Network by assigning the same color to Business Services with the same owner. Notice, in particular, that there are links connecting nodes with the same color. This characteristic is the direct consequence of the fact that inter-dependencies among Business Services also model service provisioning needs inside the same enterprise.

Any business operation needing to resort to a Business Service plays the role of Business Service Consumer. The conditions governing the relationship between Provider and Consumer are described by a Business Service
Agreement. These role players and the agreement binding them are described in the lower part of Figure 3. As it can be seen, a specific part of the agreement, called Interaction, includes the way “coordination” between the Provider and Consumer will be achieved, i.e. the interaction model explains the joint behavior between a Business Service Consumer and the Business Service Provider.

Consequently, the “boundaries” of an enterprise are blurred in favor of a flexible provisioning of needed operations through available Business Services in the Smart Business Network. In particular, the desirable plug-and-play and connect-disconnect properties of the network are made evident by the fact that the same “owner” of two Business Services, S1 and S2, with S1 depending on S2 as shown in Figure 2, may decide to stop using S2 and switch over to another one from a different Business Service Provider if the desired specification is found in the ecosystem and the corresponding Business Service Agreement that is acceptable to the owner of S1.
The subject of ‘ownership’ of a Business Service is a very interesting and important subject. In order to simplify our presentation, Business Services were introduced as the outcomes produced by significantly large ‘chunks of operations’ in a company but we have not defined any specific ‘owners’ for such individual operations. Inside a given enterprise all Business Services ultimately belong to the same company and thus, they may all be considered to belong to the same ‘owner’. This explains why all Business Services within the same enterprise were given the same color on Figure 2. However, this high-level ownership does not characterize the obvious differences that may exist for two distinct ‘chunks of operations’ in the enterprise, for example, in terms of accountability. In other words, the internal Business Services of an enterprise need a finer-level concept of ownership within the boundaries of the organization. The way this problem is approached is intimately related to the criteria with which the involved ‘large chunks of business operations’ are selected. If two companies belonging to the same segment of the same industry were to follow different criteria to make such a selection of the pieces of their operations to be modularized into Business Services, they would end up with different sets of Business Services and therefore, the standardization sought for that industry segment would likely be lost.

Leading companies in several industries have recognized that in order to benefit from economies of scale in the provisioning of their common needs from external sources and to foster more effective collaboration, they would need to modularize their business operations by following common and agreed principles. While this need may not hold true for all operations of a company, it is definitely the case for those specific operations that do not offer significant competitive advantage and are high candidates for externalization. For example, in the telecommunications industry, many large companies have agreed on a standard called Enhanced Telecom Operations Map (ETOM). A simplified and partial example of the ETOM framework is shown in Figure 4 for illustration purposes. The main operations have been modularized and organized according to a design principle dictated by the name given to the main rows and columns in the diagram.
8. Business Services as a Modeling Approach for Smart Business Networks

Figure 4. A partial view of the Enhanced Telecom Operations Map (ETOM) created by the Telemanagement Forum

In [11], the concept of aggregating large chunks of company activities according to a number of well-identified capabilities in the enterprise and three levels of accountability involved in the business operations was presented. In this framework, called Component Business Modeling or CBM, business components are identified and proposed as a standard for individual segments of the most common industries. The design principles followed to define such business components in each industry segment is not the objective of this paper. With a CBM view of the business at hand, individual Business Services have a natural owner, i.e., the individual business component whose main operations are encapsulated under one or more Business Services. As an example, Figure 5 shows a CBM view of an enterprise with the Business Services of Figure 2 overlaid onto the business component map. Thus, each component becomes the natural owner of the Business Services it provides to the rest of the ecosystem, both internally and externally to the company.
For the sake of allowing effective collaboration, a Business Service is made “available” or usable to the rest of the Smart Business Network through a set of Business Service Functions. Figure 3 above shows one Business Service Function for the given Business Service. Figure 6 offers a more complete description of these concepts, and includes several Business Service Functions as part of the Business Service Specification. Each of these Business Service Functions has an Operation Model as well as some specific behavior that governs its interaction with the rest of the ecosystem, i.e., the Interaction Model, which is derived from the Business Service Agreement. The Interaction Model is fixed for each Business Service Function and part of its behavior will be materialized through specific actions performed by any Business Services Consumer requiring the service, which are dubbed “Consumer Service Tasks” or “Service Tasks” for short.

In Figure 3 and Figure 6, the Interaction Model is represented with a set of Business Processes, thus stating that the interaction between Business Service Provider and Business Service Consumer is purely behavioral in nature. These processes obviously must interact with the Operation Model of the Business Service Function and they do so in more or less complex forms depending on the particular case at hand. The important lesson to be learned is that in business-level modeling accomplished by the proposed
8. Business Services as a Modeling Approach for Smart Business Networks

Smart Business Network, naïve artifact-passing communication (input-output parameters) does not hold as in the case of lower-level IT-oriented implementations through Web Services. It is obvious that since a Business Service encapsulates a substantially large size of company operations under each of its Business Service Functions, the Interaction Model that describes the joint behavior between a Business Service Function and the Business Consumer is much richer than a simple Web Service interface. This should be no surprise as any business-level interaction has a higher degree of complexity than just passing input and output artifacts between the involved role-players.

On the other hand, the maximum possible level of standardization and simplification sought in the Interaction Model will ensure that interoperability and effectiveness of a Smart Business Network are met by a Business Service-based model.

An Interaction Model is the public way a Business Service says explicitly to the Smart Business Network how joint collaboration will be realized. In fact, it should be noticed that the definition of the Interaction Model of Figure 6 includes some activities that are owned by the Business Service Function while others are performed by the role of the Business Service Consumer. As said above, the latter activities are represented as Service Tasks whose operational details are of the exclusive incumbency of the Business Service Consumer because the Business Service Provider does not need nor cares to know about their realization.

A Business Service Agreement includes other business rules that bind and commit the two role players while setting performance, financial understanding, and other terms and conditions. The details of this Agreement and the relationship with rules go beyond the scope of this paper.

Intuitively, the business logic encapsulated by a Business Service is thus divided into a set of Business Services Functions that shared substantial pieces of common operations among themselves. Some common processes that are used in different Business Service Functions are shown in Figure 6 as P1, P2, P3 and P4. Each of these Business Services Functions is also equipped with an Interaction Model which is the piece of the operation that rules the collaboration with the rest of the Smart Business Network, and

In fact, the Service Component Architecture standard includes a ‘conversational mode’ for assembling services that resembles the Interaction Model.
thus, is made public to the ecosystem of Business Services. This division of business logic promotes the right balance between all those chunks of operations that are kept internal to the Business Service and thus, to the exclusive knowledge of the Business Service Provider and those operations which the rest of the ecosystem needs to know about the Business Service to be able to use it.

As an important detail to be noticed from Figure 6, the Operational Model facilitates the reuse of large “chunks” of business operations across Business Service Functions of the same Business Service. As it is shown, some of the activities (processes or simple tasks) used in the Operational Model are local to a Business Service Function while others come from a shared pool in the Business Service Operation Model. Some of the supporting enterprise applications (for example, a Customer Relationship Management solution or a SAP financial package) are also shown as part of a typical Business Service Operation Model and consequently, they are also reused in the Business Service Function Operation Model.

![Figure 6. A simplified business architecture definition of a Business Service.](image)

The proposed representation of a Smart Business Network through Business Service Modeling also encapsulates all potential and complex forms of joint behavior across the network. More precisely, this Business Service-based representation of a Smart Business Network supports all
business processes needed in the operations. Indeed, the design of any business process taking place across the ecosystem can be realized as a choreography of selected nodes which are chosen to attain the sought collective behavior. Thus, we are in a position to claim that a Business Services representation of a Smart Business Network encapsulates “Potential Energy”, as any ecosystem behavior can be described by resorting to the defined business architecture of the network.

As an example, given a Smart Business Network of the telecommunication industry as represented by its Business Services, an end-to-end “Ordering Process” can be obtained as shown in Figure 7 below. In this example, the intervening Business Services are conveniently swinlaned for ease of visualization, and in each lane several different Business Service Functions of the same Business Service are used in due turn to create the telecommunications industry “Ordering Process”.

Figure 7. The “Potential Energy” contained into a Smart Business Network. An Ordering Process generated from individual Business Services in the Telecommunications Industry.
3. Conclusions and Further Research Activities

In this paper, the concept of modeling business ecosystems through Business Services has been proposed as an approach to Smart Business Networks. Business services provide the right architecture dimension and the appropriate level of abstraction for obtaining the desired characteristics of standardization, specialization, modularity and openness. Business services offered and provided by enterprises and their interdependencies offer an opportunity to reach a level of unprecedented industry-level business standardization. The Smart Business Network concepts presented enable some of the desired properties of such networks, including its ability to carry out business decisions to connect-disconnect and the capability of reasoning about matters of strategic business nature.

Dividing the behavior of Business Services into intrinsic work performed by the service and an Interaction Model that governs the joint work to be performed with its potential consumers, and exposing such Interaction Model in a public form furthers the openness about the way different ecosystem participants collaborate in the network.

On the other hand, a metamodel giving a formal foundational model to the Smart Business Network has been designed and a companion software tool to define, search and use Business Services in the Smart Business Network has also been built. This software capability includes the definition of business processes as choreographed Business Services. In Figure 8, a preliminary screenshot of the actual software tool being built for defining, searching and managing the Smart Business Network is shown. This tool also has the capability to define Business Processes sustained by the Smart Business Network.
In addition, successive decomposition of a Business Service by further refinement of the operations that its Business Service Functions comprise gives raise to finer grain of detail. Although this further refinement goes beyond the scope of the Smart Business Network definition, the approach shown in this paper can be repeated in a hierarchical form downstream. This progressive refining yields a hierarchy of Business Service ecosystems. In those cases where it makes sense, this decomposition method leads ultimately to fine-grain SOA-oriented service realizations at the IT level. Since the bridge between business and IT has always been a prevalent subject of concern, it seems that the suggested Business Services modeling and its decomposition sheds new light on this important problem for practitioners. This topic will be fully addressed in a companion paper.

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Bibliography


9. Achieving Quick Connect with the Support of Semantic Web

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Abstract

In today’s market that is filled with fierce competition, companies are organized under the form of business networks to fulfill the diversified requirements of different customers. Compared with the traditional supply chain management, Smart Business Network (SBN) is put forward as a more flexible and intelligent collaboration model between partners in the business network. In the paper, a mechanism with the support of Semantic Web is developed to achieve quick connect between business partners, which has been regarded as one of the key features of SBN.

Keywords Design, Smart Business Network, Web Service, Semantic Web, Description Logic

1. Introduction

Along with the development of technology and economy, people demand the products with better service, higher quality and lower price, which results in the more and more intense competition in the market. In this epoch, companies without collaboration with others cannot achieve satisfactory performance, even hardly survive. To face the challenge, companies are organized to build up different supply chains with the lead of main actors in each industry. Although supply chain management enables the collaboration to a certain extent, the relation of cooperation is rigid and the influenced scope is limited to strategic partners. With the emerging enabling technology, such as web service, business process management and Semantic Web, a more flexible and intelligent collaboration model between partners in the business network is put forward, which is named as
Smart Business Network (SBN). According to the definition of SBN given in Vanenburg Science Seminar, a Smart Business Network is a network of organizations coordinating their business process in a manner that exhibits adaptive, agile and robust behavior that is generated or reproduced when a robust and necessary set of networked structures and networking processes are established [23].

“Quick Connect and Disconnect” has been regarded as one of the key features of SBN. The most original connection mode between business partners is to make telephone or send e-mail. But the information exchanged under this kind of connection is not well structured. It is difficult to analyze them and to pick up valuable information. Then the EDI was applied to exchange basic daily data. However, due to its high implementation cost and low system flexibility, it hasn’t been made wide use of in the industry. To replace EDI, XML was created so that richly structured documents could be delivered over the web. And based on XML, web service becomes the enabling technology that bridges decoupled systems across various platforms, programming languages and applications. Interoperability among these applications is ensured through the use of standards such as SOAP (Simple Object Access Protocol) and WSDL (Web Services Description Language) [13]. SOAP is an XML-based protocol for exchange of information in a decentralized, distributed environment. WSDL is an XML format for describing network services based on a standard messaging layer like SOAP [22].

Whereas web service has only solved the problem of interoperability across different platforms, programming languages and applications, it doesn’t tell how to compose the services. Furthermore, although XML offers high flexibility, it does not predefine semantics, which makes it difficult to understand the exact meaning behind each tag and map the information between two services. To realize “Quick Connect and Disconnect”, we propose the utilization of Semantic Web. Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation. This is realized by marking up web content, its properties, and its relations, in a reasonably expressive markup language with a well-defined semantics. The Web Ontology Language (OWL) is a forthcoming W3C specification for such a language, which enables the creation of ontologies for any domain and the instantiation of these ontologies in the description of resources [20].

In this paper, we develop a mechanism with the support of Semantic Web to enable quick connect between business partners. In our model, the logic connection between services is realized by assigning preconditions and postconditions to every service, which describe and restrict services
possibly taking place before and after the specific service according to the agreement between business partners. And we apply similarity measure between concepts across different ontologies and basic reasoning services offered by DL-based systems to carry matches between the preconditions and postconditions of one service and the description of another service. Further we demand that business partners agree on one common set of terms used in the inputs and outputs of their services. The rest of the paper is organized as follows. In section 2, related work concerning supporting web services with Semantic Web, semantic similarity and description logic is reviewed. Section 3 discusses how the logic connection between services can be realized. We present the description of services in section 4 and the standardization of data in section 5. We explain the method to annotate services in section 6 and the process of connecting services in section 7. Section 8 offers a comparison between our model and other relevant technologies and section 9 concludes the paper.

2. Related Work

How to enable automatic discovery, composition and interoperation of web services with the support of Semantic Web has attracted recent research efforts for its potential to achieve dynamic, scalable and cost-effective infrastructure for electronic transactions in business and public administration. Many methods or frameworks have been put forward, such as OWL-S, Web Service Modeling Ontology (WSMO), Semantic Web Services Ontology (SWSO) and WSDL-S etc. OWL-S facilitates the description of services in terms of four different ontologies [15]. The upper ontology links to the profile, service model and grounding ontologies. The profile defines different properties of the service. The service model describes the behavior of the service in terms of processes and control constructs. The grounding binds processes, inputs and outputs in the process model to some transport protocol described in a WSDL document. WSMO separates the elements needed to describe services into four parts: ontologies that provide the terminology used by other elements; goals that state the intentions that should be solved by web services; web services descriptions that define various aspects of a web service; and mediators which resolve interoperability problems [7]. SWSO presents a conceptual model by which web services can be described and a formal characterization of that model given in first-order logic [5]. In WSDL-S, formal semantic models relevant to the services are maintained outside of WSDL documents and are referenced from the WSDL document via WSDL extensibility ele-
Apart from the methods above, BPEL4WS provides another approach to compose web services manually and enables the specification of executable and non-executable business processes [2]. More detailed comparison between our method and these technologies will be brought forth in latter part of this paper.

Semantic similarity is one of the hot topics in the research domain of semantic web, the objective of which is to compare concepts across different ontologies. Usually different organizations possess their own information systems, along with their own intended models and, therefore, their own ontologies. Most part of previous attempts to measure similarity between terms of different ontologies have been based on an integrated ontology that was established manually or semi-automatically. Path distance, feature-matching and information content are methods to assess semantic similarity within a single ontology. Path distance is calculated between concepts in the hierarchical structure within the single ontology [6], [9], [8]. Based on Tversky’s ratio model [21], feature-matching uses common and different characteristics between objects or entities to compute semantic similarity. Applying information theory [18], information content makes use of the degree of informativeness of the immediate superconcept that subsumes the two concepts being compared to define a similarity measure [14], [16].

However the use of a single ontology is costly, since ontology integrations need to treat overlapping concepts and inconsistencies across ontologies. Furthermore, compromises are difficult to maintain when new concepts are considered. Rodriguez and Egenhofer put forward one matching process to measure semantic similarity without the use of a single ontology [17]. Their method is based on Tversky’s ratio model and uses synonym sets, distinguishing features and semantic relations of entity classes. The limitation of this matching process is that it cannot be used to evaluate semantic similarity of complex concepts, as it is difficult to describe complex terms with synonym sets, distinguishing features.

Description Logics (DLs) are a family of logic based knowledge representation formalisms. Concepts (unary predicates) and roles (binary relations) are the basic notions in DLs, and a specific DL is mainly characterized by the constructors it provides to form complex concepts and roles from atomic ones [4], [3]. We can take the following concept as an example, which describes “A cooler connected to a reactor which, in turn, has a part that is a stirrer”:

\[
\text{cooler} \sqcap \exists \text{connectedTo} . (\text{reactor} \sqcap (\exists \text{hasPart} \text{stirrer}))
\] (1)
DLs are perhaps best known as the basis for widely used ontology languages such as OWL [11]. The decision is motivated by the fact that DL-based systems can provide their users with various reasoning capabilities to infer information that is not explicitly represented. Such reasoning services are typically realized by highly optimized implementations of tableau decision procedures, which have shown their high effectiveness in applications except for the high complexity of the worst case [10], [12]. In this paper, the representation of domain knowledge based on Rodriguez and Egenhofer’s work and we enlarge the scope of semantic relations to ALC DL.

3. Logic Connection between Services

Each business partner exposes their services via web services. In order to achieve some objectives these services can be organized as internal business processes within one business partner or business collaborations between business partners. A simple example including a manufacturer and a supplier as two business partners is shown in Fig. 1 in the form of cross function diagram. The manufacturer and the supplier provide four and two services respectively. The example begins with “Production Plan”, which is not only an activity carried out by some department in the manufacturer, but also a service processed by the manufacturer. And the link between “Quote Request” and “Quote Response” is a connection established between the manufacturer and the supplier.
Each service is defined with one WSDL file, which only describes the input, output and the operation of the service, but cannot tell which service should be executed before or after. Therefore, while one manufacturer and one supplier want to set up the business partner relationship between them and the connection of the services they provide, it is difficult to achieve the collaboration without coming to an agreement on how they work together and the relation between the services. The agreement can define the connection between the manufacturer and the supplier as detailed business process by using any business process definition languages, such as BPEL4WS. The shortcoming of the connections established in this way is that they are so rigid that they cannot be modified easily to adapt the fast changing business environment.

Another way to define the connection in the agreement is to depict the relations between the services. The relation tells which services may happen before or after some specific service. In the example above, “Quote
Request” should happen before “Quote Response” and “Purchase Order Request” may happen after. In the mechanism put forward in this paper we prefer the second way to define the connection between services of different business partners, as it is more flexible. We attach a set of preconditions and postconditions to every service by using the extensibility elements of WSDL, which indicate services possibly taking place before and after the specific service according to the agreement between business partners.

4. Description of Services

When we have the preconditions and the postcondition of one service, we want to find the appropriate service to make a connection between them. We can realize the search by using service names and comments, but plain text description of service could be misunderstood in different contexts. For example, from the service name “selling apple” we cannot tell whether the service provider sells the fruit apple or the computer of the brand “Apple”. We can seek help from semantic to improve the effectiveness of search. We also have to admit the fact that it is unrealistic to describe services completely with ontologies. If one ontology could describe all the services of some business partner, the ontology would be very huge and too costly to establish, saying nothing of reasoning on it. In order to balance the effectiveness and efficiency of search, we divide the description of services into two parts: operation description and domain description.

RosettaNet standards provide a business framework that allows individual companies to enhance the interoperability of business processes across the global supply chain [19]. Partner Interface Processes (PIPs) are part of RosettaNet standards, which model atomic business processes between two business partners. PIPs fit into seven Clusters, or groups of core business processes, which is broken down into Segments. Within each Segment are individual PIPs. In our model, the operation description of services is based on the classification of PIPs as it is widely applied in practice. Of course, the hierarchy structure can be modified or subdivided further to fit every specific situation. One example is shown in Fig. 2. It can be realized as an operation ontology based on the simple is-a relation. Then the operation description of every service gives out which sort of operation in the hierarchy structure the service falls into. For example, the service “Quote Request” in Fig. 1 belongs to the sort of operation “Quote Request” in Fig. 2. We implement the operation description of every ser-
vice by associating the operation element in the WSDL document of the service with the terms defined in the operation ontology.

![Hierarchy Structure for Operation Classification](image)

**Figure 2** Hierarchy Structure for Operation Classification

In addition to operation description, every service has domain description, which gives out the domain information related to the service. For example, we can associate the domain description “PetFood” with the service “Quote Response”, from which we can tell that the service can answer quote request about pet food. Every domain description may include one or several terms and every term is defined as a class in the domain ontology provided by the service owner. Rodriguez and Egenhofer proposed a model of class representation with synonym sets, distinguishing features and semantic relations of classes [17]. However, they only consider two basic semantic relations, is-a relation and part-whole relation, which results in the limited capability to define complex concepts. Based on Rodriguez and Egenhofer’s work, we enlarge the scope of semantic relations to ALC DL. Our model of class representation is described as below:

**Synonym Sets**

The case when the same word denotes more than one meaning is called polysemy and the case when different words denote the same or very similar entity classes is called synonymy. Thus, synonym sets are able to give clearer meaning than a single word that denotes a class. For examples, the word bank with its synonym sets constituted by bank, banking company
and depository financial institution avoids the possibility of being misunderstood as a building of financial institution or a slopping land.

**Distinguishing Features**

Usually, attributes are used to describe different types of distinguishing features of a class. According to the proposition Rodriguez and Egenhofer, distinguishing features can be subdivided into functions, parts, and attributes. Function can represent the action for which the class is particularly fitted or employed. For example, the function of school is to educate. Parts are constituent elements of a class, such as the roof and wall of a building. Attributes are the third type of distinguishing features, which indicate additional characteristics of a class except for functions and parts.

**Semantic Relations**

ALC DL is the smallest propositionally closed DL, which allows classes constructed using booleans ($\cap$, $\cup$, $\neg$), restricted quantifiers ($\exists$, $\forall$) and atomic roles. For example, persons all of whose children are either doctor or have a child who is a doctor can be expressed by using ALC DL as below:

$$Person \cap \forall hasChild.(Doctor \cup \exists hasChild.Doctor)$$

We can see that the concept above cannot be denoted easily with Rodriguez and Egenhofer’s model of class representation. That’s the reason why we apply ALC DL in semantic relations of classes. Furthermore, ALC DL is able to support various reasoning services. However, we do not choose more expressive DL, such as SHOIQ DL, which comes from the consideration of the balance between expressiveness and complexity.

In our mechanism, we implement the domain description of every service by using extensibility elements of WSDL and associating them with the terms defined in the domain ontology.

**5. Standardization of Data**

As we have mentioned before, the inputs and outputs of every service are defined in WSDL document associated with the service. Standardization of the words used in inputs and outputs can enhance the quick connect between services of different business partners. RosettaNet standards provide a common vocabulary platform for conducting business within the business network, which include one business dictionary and one technical dictionary [19]. The RosettaNet Business Dictionary designates Business Properties, Business Data Entities and Fundamental Business Data Entities
used in basic business activities. The RosettaNet Technical Dictionary provides common properties for describing products and services. In our model, we also demand that business partners agree on one common set of terms used in the inputs and outputs of their services, which we call one dictionary too. The dictionary can be one widely accepted by the specific industry, such as RosettaNet dictionaries by IT companies. It can also be set up between two business partners or offered by one leading company in the business network. In our mechanism, the dictionary is realized as an XML schema. Once the dictionary is at place, it can be used to annotate the terms used in the inputs and outputs of every service.

6. Annotating Services

So as to realize the logic connection between services, description of services and standardization of data, we annotate the WSDL document of every service by consulting the method applied in WSDL-S [1]. At first, we attach preconditions and postconditions to every service. The preconditions and postconditions include the operation descriptions and the domain descriptions of the services possibly taking place before and after the specific service. Thus we divide preconditions and postconditions into preoperations, predomains, postoperations and postdomains. They can be added to the operation element in the WSDL document of the service as extensibility elements. Then in order to implement the operation description and the domain description, we add the domain element in the operation element and associating them with the terms in the corresponding ontologies. Finally we annotate the elements used in the inputs and outputs with the terms defined in the dictionary. One example is shown in Fig. 3. In the example, the operation is referred to the term QuoteRequest in the operation ontology, which indicates its sort of operation. And the input message is a single element ProductName defined in the dictionary.

Figure 3 Sample for Annotating Services in WSDL
7. Connecting Services

Here we explain the process of connecting services by applying our mechanism. To simplify, we just take one service of one business partner and connect it to the services of another business partner. We reuse the example in Fig. 3. When we want to know which services can take place after it, we look into its postconditions and know that its following services should be of the sort QuoteResponse and in the domain DogFood. Thus we search in the repository where the information of all the services of its business partners is stored. At first, we find all the services belong to QuoteResponse or the parent sorts subsuming QuoteResponse. Then we filter the services with the domain Dogfood. As the domain description is built on three components: synonym sets, distinguishing features and semantic relations, the filtering process can be divided into two parts: similarity measure and subsumption filtering.

Rodriguez and Egenhofer put forward a method to measure semantic similarity among classes from different ontologies [17]. Their method is based on Tversky’s ratio model and the set-theory functions of intersection \(A \cap B\) and difference \(A/B\), which is shown in equation (3). In the equation, a and b are classes; A and B correspond to the description sets of a and b, i.e. synonym sets and sets of distinguishing features; \(||\) is the cardinality of a set; and \(\alpha\) is a function that defines the relative importance of the different characteristics.

\[
S(a, b) = \frac{|A \cap B|}{|A \cap B| + \alpha(a, b)|A/B| + (1-\alpha(a, b))|B/A|}
\]

for \(0 \leq \alpha \leq 1\).

We apply their method in the similarity measure. The similarity between the specific domain description and the terms in the domain ontology of the other business partner is evaluated by using equations (4) and (5). In equation (4), the functions \(S_w\) and \(S_u\) are the similarity between synonym sets and distinguishing features of classes a in ontology p and b in ontology q; \(w_w\) and \(w_u\) are their respective weights. And in equation (5) \(S_p\), \(S_f\) and \(S_a\) are the similarity measures of parts, functions and attributes; and \(w_p\), \(w_f\) and \(w_a\) are their corresponding weights.
\[ S(a^p, b^q) = w_u \square S_u(a^p, b^q) + w_n \square S_n(a^p, b^q) \]

for \( w_u, w_n \geq 0 \) and \( w_u + w_n = 1 \). \hfill (4)

\[ S(a^p, b^q) = w_p \square S_p(a^p, b^q) + w_f \square S_f(a^p, b^q) + w_a \square S_a(a^p, b^q) \]

for \( w_p, w_f, w_a \geq 0 \) and \( w_p + w_f + w_a = 1 \). \hfill (5)

When we find the terms with high similarity in the domain ontology of the other business partner, the subsumption filtering is to find the services in these domains and their parent domains. Since the domain ontology is based on ALC DL, classification, one of the basic reasoning services offered by DL-based systems, can be used to determine some subsumption relations that are not explicitly represented. As in the example in Fig. 3, we want to search for one service of the sort QuoteResponse and in the domain DogFood to follow the given service. However, what we have now is one service in the domain PetFood and the sample knowledge realized in OWL in Fig. 4. The knowledge is stored in the domain ontology and tells that dog eats dog food, pet eats pet food and dog is one kind of pet, from which the inference that dog food is one kind of pet food can be drawn. Thus the service in the domain PetFood fulfills the requirement.
After the filtering process, we have a list of all the services possibly following the given service. Then we have to compare their inputs and outputs so that we can determine whether two services can be connected from the point of data flow. As the elements in the inputs and outputs are associated with the terms defined in the common dictionary, the comparison can be easily realized.

Finally the operation sequence and the data mapping between services of different business partners are determined manually. And then all the service can be put on a workflow engine for running.
In the context of business network, all business partners within the same business network have to share the same operation ontology and the same dictionary. While every two business partners need establish the mode how they collaborate, from which preconditions and postconditions of every service can be designated. And every business partner has his own domain ontology.

8. Relation with Other Relevant Technologies

In this section, we will compare our model with other relevant technologies, such as OWL-S, WSMO, SWSO, WSDL-S and BPEL4WS, from three aspects: logic connection between services, description of services and data connection between services.

Logic Connection between Services

In OWL-S, the profile describes the preconditions required by the service and the expected effects that result from the execution of the service. For example, a selling service may require a valid credit card as a precondition and the card is charged as an effect. WSMO, SWSO and WSDL-S have similar elements. We can see that preconditions and effects in OWL-S emphasize on the description of the facts that should be held before and after the execution of one service, while our model is concentrated on the logical relation between services according to the agreement between business partners. Our choice comes from the usual instances in reality that business partners should first discuss and agree on how they collaborate and then carry out their business with the support of information technology. Their agreement on the logic connection between services also enhances the quick connect between their services. In BPEL4WS, the logic connection between services is constructed manually, as is also supported by OWL-S, WSMO and SWSO. The disadvantage of the connections established in this way is that they are so rigid that they cannot be modified easily to adapt the fast changing business environment.

Description of Services

In OWL-S, serviceClassification and serviceProduct are two prosperities specifying respectively the type of service provided and the products that are handled by the service. Both of them define a mapping from a profile to a specific OWL ontology. However, OWL-S does not tell how to establish these ontologies. In our model, we divide the description of services into two parts: operation description and domain description. The related
operation ontology is based on the classification of RosettaNet PIPs, as it is widely applied in practice. And the class representation of the related domain ontology is comprised of synonym sets, distinguishing features and semantic relations based on ALC DL, which can support similarity measure between complex concepts across different ontologies. In other technologies, this issue has not been paid special attention to.

**Data Connection between Services**

WSMO underlines the importance of mediation, which addresses the handling of heterogeneities that naturally arise in open environments. Nevertheless, WSMO does not give a solution on how to create the mapping services. Other technologies talk little of this issue. Our model requires that a common set of terms used in the inputs and outputs of services should be established between business partners or offered by one leading company in the business network. Then the data mapping between services can be easily realized.

9. Conclusion

The fierce competition in the market requests that each company have to be concentrated on their core competences. As a result, no company has the capability to fulfill the requirements of its customers alone. They need collaborate with other companies and are urged to be organized under the form of different business networks with particular objectives. The outstanding achievement of every company is closely linked to the performance of the business network to which it belongs and the competition in the market is between business networks, not just between individual companies. In this context, SBN is put forward and “Quick Connect and Disconnect” has been regarded as one of the key features of SBN. This paper develops a mechanism with the support of Semantic Web to enable quick connect between business partners. From its comparison with other relevant technologies, we can see that our model not only offers a powerful and flexible way to achieve quick connect, but also emphasizes the need for discussion and agreement between business partners before technological implementation from the management view point.
References


Report Plenary Session

Session title: “The state of the art”
9.00-12.00 June 15, 2006.

Presenters: Javier Busquets; Steve Muylle; Otto Koppius; Jorge Sanz; Li Zheng.
Reporter: Ulad Radkevitch

The broad scope of research on smart business networks (SBNs) has been reflected in the papers presented at the plenary session. The five papers, originating from business schools as well as technical research institutions, covered research areas such as organization theory, information systems research, computer science and social network analysis.

The papers at the plenary sessions substantially draw on the work presented at the Smart Business Network event in 2004 and often aimed at extending previous findings. One of the key trends across the presentations has been the growing maturity of the SBN research in terms of combining theoretical elaboration with the empirical work. Another trend has been the emphasis on different aspects of interaction between SBNs and the environment, such as the impact of SBNs and the environment on each other, as well as the discussion of drawing clear borders between SBNs and the environment.

The paper “Adaptability in Smart business Networks” by J. Busquets, J Rodon and J. Wareham featured a study on adaptability as a key characteristic of SBN behavior. In this theory-driven study the authors drew on theories of learning to develop a framework of adaptability. The framework accommodates four types of adaptation – automatic responses, assimilation, accommodation and environmental enactment – that are dependent on organizational awareness and resources. An empirical examination of adaptability was carried out in the case study of Multiasistencia, a Spanish household repair service company.

The reviewer and discussants acknowledged a valuable theoretical contribution and impressive amount of empirical work conducted by the research group. However, it was noticed that the huge amount of empirical data made it hard to distinguish between facts relating to different constructs in the framework; there is a need for further interpreting efforts. The discussion centered mainly on the aspects of smart adapting behavior and revealed that the four types of adaptability are in a way evolutionary and represent a development from passive to active behavior. Another highlighted aspect of smart behavior was that while Multiasistencia switched from centralized to decentralized control and while the focus of
control moved from people to processes, these were primarily talented people who enabled both transition to and functioning of the active types of adaptability.

The paper “Electronic Intermediaries in Smart Business Networks” by A. Basu and S. Muylle focused on the role of electronic intermediaries in SBNs. In their conceptual model, the authors examined business performance of electronic intermediaries as a function of the fit between business model of electronic intermediary, its evolutionary context and service scope. The conceptual model incorporates a typology of business models and services developed by the authors. An empirical validation of the proposed model has been carried out via a multiple case study encompassing ten electronic intermediaries.

Similarly to the previous paper, a significant contribution to theory and practice was acknowledged but there was also a call for a more extensive analysis of the rich empirical data the authors had gathered. Ways of analyzing were suggested, such analyzing the cases across three dimensions/constructs in the conceptual model and adding geographical location and industry structure as explanatory variables. A need for methods to measure business performance at the network level, rather than only the actor and dyad level, was highlighted, as well as the importance to draw a border between networks and their context/environment. The limits of the governance role of intermediaries were discussed. It was noted that the purpose of the conceptual model was not to analyze the causes for good performance, but rather to describe the configurations of factors behind such performance.

In the next paper “Business Services as a Modeling Approach for Smart Business Networks” by J. Sanz, N. Nayak and V. Becker the architecture of SBNs was explored through the business modeling perspective. The authors introduced the concept of modeling of companies and their ecosystems through business services. This modeling approach should allow for optimizing processes within and between companies, decomposing supply chains and whole industries and, finally, producing positive effects on the environment.

It was pointed out that the paper took further some of the ideas about SBN modeling presented at the SBN meeting in May 2004. Part of the comments dealt with the levels of abstraction in the proposed and similar approaches. A common challenge to model-driven architectures is that they either require a very general platform or need to be very domain-specific. Reliance on multiple levels of abstraction needs to be avoided. The presented approach was also found to resonate with the resource-based view of the firm, according to which “smart networking” can be seen as driven by the differences in the kinds and levels of resources firms
possess. The questions whether the model is dynamic and feasible to implement was raised.

The last paper of the plenary session “Achieving Quick Connect with the Support of Semantic Web” by L. Xiao and L. Zheng took another step toward providing foundation for the architecture and design of SBNs. The authors set a path toward achieving quick connect capabilities between actors in SBNs via the use of Semantic Web. The quick connect capabilities are realized via establishing logic connections between services by specifying their preconditions and postconditions to enable matching with descriptions of other services. The matching is realized by using similarity measure across different ontologies and Description logic.

The proposed approach was found interesting, particularly in part of combining ontologies at the operation and domain levels. Questions arouse with regard to the implications for the constraints when the services are not performed sequentially but in parallel. Concerns were expressed about the proposed implementation, particularly that a potentially large number of outcomes can result in an extreme decision making complexity. A need to differentiate between internal process modeling and the way it is exposed to partners was highlighted. Finally, a thought was expressed that smartness of business networks depends on how standardization and commodization of processes and services are dealt with.
10. Orchestrated Business Networks in the Mobile Services Industry

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Abstract

Based on the analysis of the Finnish and Japanese mobile services markets this article argues that the Internet-like, mix-and-match approach to the development of services by loosely coupled networks of companies is not necessarily optimal when dealing with systemic innovations such as mobile data services. In order to manage increasing technical and commercial complexity, special attention needs to be paid to the governance mechanisms of extensive business networks. The optimal coordination mechanism is highly dependent on the industry life cycle stages. The Japanese “keiretsu” type, closely coordinated and orchestrated networks appears to be successful in the initial stages of evolution.

Keywords business networks, complexity, keiretsu, mobile services, mobile internet, mobile services industry, orchestration, smart business networks, systemic innovation, industry life cycle, cellular industry
1. Introduction

One of the hottest topics in the telecommunications industry is the question of whether the optimal route to successful service business should be based on the logic of the traditional telecom world, or the logic of the Internet world. Both approaches have clear advantages but also obvious disadvantages: Traditional teleoperator world with strong operator control and regulated technology choice has proven to lead to highly reliable telecommunications services. However, at the same time this “ITU approach” has been accused for a slower rate of innovation and high entry barriers for new technologies, services and players. Likewise, the Internet world, with less regulation and more market-driven choice of technologies, is considered to have higher speed of innovation and lower entry barriers. However, the openness of the Internet world has created security risks and other types of problems. It is understandable that the proponents of both world-views have strong faith in the superiority of the approach they are supporting. But in the end of the day, the result of this “War of the Worlds” will be a cohesion of the two – something bigger and better than neither of these worlds can offer today.

Behind the ongoing debate on the superiority of various technologies and architectures, academics and practitioners alike are trying to solve another issue – the challenge of identifying and implementing an optimal coordination mechanism for the emerging new world-order. As Figure 1 demonstrates, over the past then years we have witnessed two very different routes to successful digital services when analyzed along two dimensions, the level of investment in technology and marketing, and the number of users these new services have attracted over time.
Many of the “killer applications” that have emerged during the recent years were created in a bottom-up fashion without major investments in technology or marketing (or sometimes unintentionally, as a by-product of a bigger project). Success stories, such as the evolution of the World-Wide Web, or the Internet telephony company Skype, show how sometimes the users simply adopt a new technology or service, and turn it into a huge success. At the same time we have seen another, more technology-centric approach where either the industry has collectively created a new technology or standard, e.g., the Wireless Application Protocol (WAP), the third generation mobile standards (UMTS), or the digital television standard (DVB in Europe), or strong individual companies within an industry has developed a new type of service (e.g., the I-mode mobile internet service of NTT DoCoMo in Japan). Interestingly, these top-down initiatives have been more successful in Asia than, for instance, in Europe.

The success of many “start small – grow big” type service innovations in the Internet world has given support to the view that time has come for virtual business models based on flexible, innovative and efficient networks of specialized companies. Building on the positive experiences in the PC industry or in the open source world, there is a strong belief that
loosely coupled networks of companies and developers will be the road to business success. However, based on the analysis the Finnish and Japanese mobile services markets, this article argues that the bottom-up, Internet-like approach is not necessarily optimal when dealing with systemic innovations such as mobile data services, which can be described as complex goods. According to Mitchell and Singh [18], complex goods represent "an applied system with components that have multiple interactions and constitute a nondecomposable whole". For mobile data services, the key components (on a very high level of abstraction) are handsets, mobile networks, applications and content. In order to manage the technical and commercial complexity in today’s mobile services business, special attention needs to be paid to the governance mechanisms of extensive business networks, or ecosystems, combining traditionally separate industries such as telecommunications, media, entertainment, and automotive industries.

This article argues that the coordination of emerging business networks is particularly critical in situations where core technologies and services change as dramatically as what the mobile industry is currently experiencing. Furthermore, the optimal coordination mechanism is highly dependent on the maturity of technology and services, and the level of user acceptance and adoption of the services. Based on the comparative analysis of the operator-driven, closely coordinated and orchestrated structure of the Japanese market, and the horizontal and modular "mix-and-match" structure of the Finnish market it is argued that for complex, systemic innovations such as mobile data services, closer integration leads to more successful services during the pre-commercialization and introduction stages of industry life cycle [8].

The conclusion of the article is that albeit loosely coupled, ad-hoc business networks are considered to be highly innovative and efficient coordination mechanism for multiple types of product and service innovations, for systemic innovations like mobile data services, the role of tightly orchestrated and coordinated business networks is essential. For instance in Japan, successful mobile services, such as NTT DoCoMo’s i-mode service, are building on the traditional Japanese way of doing business in networks of companies orchestrated by one or a few leading companies. The way NTT DoCoMo created the successful service concept builds on the traditional concept of keiretsu, an industrial group that coordinates the activities of member firms and also finances their investment activities [13].

The structure of the article is the following: In section two, earlier theories of business networks, modular systems and systemic innovation are reviewed; the following section presents a comparison of the Japanese and
the Finnish mobile markets; section four discusses the findings and concludes the paper.

2. Background

The role of business networks has been widely discussed over the past fifteen years. One of the milestones in this development was the introduction of the concept of "virtual corporation" by Davidow and Malone [5] in 1992. They envisioned a new kind of company that would "appear almost edgeless, with permeable and continuously changing interfaces between company, supplier, and customers" (p. 5-6). The emergence of the Internet created high expectations for new kinds of electronic markets that would "leverage information technology to match buyers and sellers with increased effectiveness and lower transaction costs", and therefore lead to "more efficient, friction-free markets" [3]. Likewise, Kambil and van Heck anticipated that along with the Internet "the cost of searching for trading partners, verifying their capabilities, and monitoring contracts fall dramatically" [14]. Chesbrough and Teece [4] positioned the discussion of virtual organizations and alliances in the context of corporate innovation and outsourcing. They noted that "virtual organizations and integrated companies are at opposite ends of the spectrum" [4] while alliances (and business networks) occupy a kind of organizational middle ground. Chesbrough and Teece emphasized that the decision to use decentralized, or virtual, approaches, and the decision to rely on internal organization, depend on the innovation in question. They pointed out that some innovations are autonomous, that is, they can be pursued independently from other innovations, while some innovations are systemic, i.e. their benefit can be realized only in conjunction with related, complementary innovations [4].

The question of vertical integration strategies of companies, i.e. whether to rely on internal organization, to join business networks or alliances, or to use the marketplace as a coordination mechanism, is by no means a novel issue. Based on a literature review, Vesa [26] identified several key forces influencing firms' decisions about the level of vertical integration. These forces were the maturity of the market [21], market uncertainty [11], the level of environmental change [18], the nature of technological change [2], cultural issues [10], timing [2], and the complexity of goods [18]. According to Vesa [26], each of these forces can make vertical integration a more or less attractive strategic alternative. In the contemporary business climate, however, the network paradigm is the dominating mindset in most industries. Achrol and Kotler [1] argue that vertically integrated firms are "morphing into internal and external networks" that promise "superior in-
formation processing, knowledge creating, and adaptive properties” and are “distinguished by recipocity, interdependency of ties and non-hierarchical means of control” – making them “a new managerial ethos”.

Despite the benefits of the network paradigm praised by Achrol and Kotler, Chesbrough and Teece emphasize that systemic innovations (such as mobile services) “require information sharing and coordinated adjustment throughout an entire product system” [4]. They argue that “unaffiliated companies linked through arm’s-length contracts often cannot achieve coordination”, not to mention tackling “the inevitable conflicts and choices that arise as a systemic innovation develops.” Furthermore, Chesbrough and Teece [4] argue that the coordination of a systemic innovation is “particularly difficult when industry standards do not exist and must be pioneered” – a challenge that was faced in Europe during the launch of WAP services a few years back. In the mobile industry the main problem is not so much the lack of standards as such, but the quality of standards and the large number of options in the specifications, resulting from the plethora of conflicting interests of various stakeholders. Chesbrough and Teece [4] note that "once a standard has been established, virtual organizations [or loosely coupled business networks] can manage further innovation quite well. But when industry begins to advance to a new level, the cycle begins anew.” This development is clearly visible today, as the mobile industry is in the process of moving from the 2nd generation GSM world to the 3rd generation UMTS mobile systems.

It is important to bear in mind, however, that Chesbrough and Teece [4] recognize that tightly coordinated business networks can be successful even when dealing with systemic innovations, such as mobile data services. But in those cases "the most successful virtual companies sit at the center of networks that are far from egalitarian", putting these strong central players are in a "better position to drive and coordinate systemic innovation” (p. 133). In other words, in the business networks run by companies like Intel, Microsoft, NTT DoCoMo, or Nokia, in the spirit of George Orwell’s book Animal Farm (1945), all members of the network are equal, but some companies are more equal than others – a feeling widely shared for instance amongst the subcontractors of Nokia. Furthermore, Chesbrough and Teece find similarities between successful virtual organizations and the way in which Japanese keiretsu are organized (the concept of keiretsu will be discussed in more detail in the following section). This leads us to the concept of business network orchestration, which will be discussed next.

According to a definition by Wallin and West [29], business orchestration refers to activities through which a company combines the skills of its partners to its own skills in order to create a superior product or service of-
fering. Hinterhuber [12] introduced the term “virtual value chain orchestration” as “a way of creating and capturing value by structuring, coordinating, and integrating the activities of previously separated markets, and by relating these activities to in-house operations with the aim of developing a network of activities that create fundamentally new markets.” He made also a distinction between the task of network configuration (i.e., selecting partner companies) and network management (i.e., optimal resource utilization). Hinterhuber raises also the question of to which extent can networks be intentionally built – and concludes that “in our view, deliberation, luck, and spontaneous emergence are equally important factors in shaping a network’s overall evolution” [12].

**Autonomous versus systemic innovation**

As Chesbrough and Teece pointed out, the decision to use virtual approaches, or to rely on internal organization, depend on the type of innovation in question, i.e. whether the innovation is autonomous or systemic. They argue that the distinction between autonomous and systemic innovation is fundamental to the choice of organizational design: “When innovation is autonomous, the decentralized virtual organization can manage the development and commercialization tasks quite well” [4]. However, “when innovation is systemic, members of a virtual organization are dependent on the other members, over whom they have not control.” Chesbrough and Teece conclude that “when innovation depends on a series of interdependent innovations – that is, when innovation is systemic – independent companies will not usually be able to coordinate themselves to knit those innovations together” [4]. Along the same lines, Langlois and Robertson [16] note that “systemic innovation would be more difficult in a modular system, and even undesirable to the extent that it destroyed compatibility across components” (p. 320). Therefore, “a vertically integrated firm may have some advantages in coordinating systemic innovation” [16].

Not everybody agrees with Teece’s view of the superiority of internal organization (or tightly coordinated networks) in managing systemic innovation: De Laat [6] argues, based on his analysis of the DVD industry, that “systemic innovation today can only be undertaken by alliance networks.” As discussed earlier in this article, mobile data services are what Mitchell and Singh [18] call complex goods, i.e. “an applied system with components that have multiple interactions and constitute a nondecomposable whole”. Based on the success of the PC industry, several attempts have been made in order to decompose the system of mobile data services. The concept of modularity plays a central role in this process, so next we will go briefly through some of the principles of modular systems.
Modular systems

The concept of modularity has been widely used in the context of product design. Sanchez and Mahoney [23] define modularity as “a special form of design which intentionally creates a high degree of independence or ‘loose coupling’ between component design by standardizing interface specifications” (p. 65). In other words, the goal of modularity is to make a complex good, which “constitutes a non-decomposable whole” [23], decomposable through standardization. A modular architecture, on the other hand, is “a special form of product design that uses standardized interfaces between components to create a flexible product architecture” (p. 66). The loose coupling of component designs “allows the ‘mixing and matching’ of modular components to give a potentially large number product variations, distinctive functionalities, and/or performance levels” [23].

For the purposes of our research, an intriguing question is whether mobile services can be modular, and would it be possible to standardize interfaces between services components and to create a modular service architecture, i.e. a “nearly independent system”. As discussed earlier in this article, systemic innovation requires a lot of coordination. However, Sanchez and Mahoney argue that “the standardized component interfaces in a modular product architecture provide a form of embedded coordination ...making possible the concurrent and autonomous development of components by loosely coupled organization” [23]. This relates directly back to our earlier discussion about using external business networks more intensively in the development of mobile services. They suggest that “new approaches to decomposing and structuring product designs have enabled the adoption of more structurally decomposed – and thus more adaptable – organization designs for creating products” [23]. Once again, a key question is whether such new approaches enable new kinds of services designs? As we will see later in this article, the Finnish mobile services market has been a “living lab” for attempts to apply the mix and match approach in a complex service industry – with somewhat contradictory results.

This concludes our brief overview of earlier research and theories of vertical integration vs. external business networks, systemic innovations, and modular systems. Next we will move on to the comparative analysis of the two case markets – Japan and Finland.
3. Mobile services market in Finland and Japan

The Finnish and Japanese mobile services markets were chosen as case markets because they represent the opposite ends of the spectrum when it comes to industry structure (i.e., horizontal or vertical) and dominant product architecture (i.e., modular or integrated). This dichotomy is based on the Double Helix model by Charles Fine [7]. Figure 2 describes the current structure of the two markets.

![Figure 2 Structural comparison of the Finnish and the Japanese mobile services markets]

The Finnish mobile services market is a horizontal / modular market where for the past fifteen years handsets and subscriptions have been sold separately as bundling and handset subsidies were prohibited. However, bundling was allowed for 3G handsets and subscriptions starting April 1, 2006 which will lead to considerable changes in the market structure. While the 3G market is moving towards operator-driven business networks, the non-SIM-locked model will remain for 2G handsets and subscriptions. The horizontal/modular market structure amplified by the regulatory framework prohibiting handset subsidies and fixed-term contracts has led to a price war within each layer of the horizontal market as mobile operators have had little incentive – or means – to compete for instance by bundling, unlike in most markets in the world [25]. The Finnish market has been a rare case a mobile services market with a PC-industry like “mix-and-match” architecture targeting at modularity and standard interfaces, as discussed earlier in this article.

The Japanese market, on the other hand, is the exact opposite of the Finnish market. In Japan, vertically organized mobile operators with inte-
grated service architecture have dominated the market. Each operator or-
chestrates a broad network of external companies crossing traditional in-
dustry boundaries. A good example of the role of orchestrated business
networks is the creation of the i-mode mobile internet service by NTT
DoCoMo. According to Kodama [15], NTT DoCoMo created seven work
groups to tackle the various areas of the new systemic innovation. Each
work group then started to build collaborative networks with various in-
dustries with relevant and complementary competencies (see Figure 3).

Even though the network depicted in Figure 3 is not based on any sys-
tematic network analysis, it demonstrates how the new business unit took
advantage of telecom giant NTT’s strong position in the Japanese econ-
omy and started to weave a web of relationships across multiple industries.
This approach can be understood in the light of the Japanese concept of
“keiretsu”, a group of companies led by one or a few lead firms. NTT
DoCoMo’s business ecosystem can be seen as a horizontal, or intermarket
keiretsu [17], which involves affiliation between firms over a wide range
of industries, such as banking, insurance, manufacturing and trade. In other
words, the Japanese mobile services business networks represent a "kei-
retsu of the digital age" where the mobile operator acts as the lead com-
pany. However, even in Japan the regulation is changing dramatically: In
2005 the government granted three new radio spectrum licenses, and the
mobile number portability (MNP) will be introduced in 2006. These
changes will take the Japanese market towards a more modular product
architecture and horizontal industry structure. Vesa [27] anticipates that
the impact of these regulatory changes will be dampened by the Japanese
business culture and traditional ways of business cooperation.
Figure 3 The seven work groups building the i-mode concept

From a network research point of view the case markets represent two very different kinds of business environments. The Japanese operator-driven business networks can be described as centralized networks in which suppliers are tied to a lead firm, and "standards of compatibility are laid down by the lead manufacturers and may differ from one lead to another" [16]. In the Finnish market, networks are decentralized, that is, standards are determined jointly by various players in the market (or rather, by international standardization organizations). In decentralized networks, "no single member of the network has control, and any firm that tries to dictate standards ...risks being isolated if users and other producers do not follow" [16]. In reality, however, for instance Nokia has tradition-
ally dominated many areas of the Finnish mobile industry through its market power especially in handsets. Next we will analyze the two case markets by using the Mobile Market Matrix [27].

4. The Mobile Market Matrix

The Mobile Market Matrix [27] presented in Figure 4 analyses the structure and dynamics of the Finnish and Japanese mobile markets along two dimensions, which are the dominant service architecture and the dominant industry structure. As Figure 4 shows, there can simultaneously several business models, or market configurations, in the same market. Likewise, an operator can assume different kinds of business models in different markets. This can be explained by the nature of technological evolution in the telecom industry, which happens in generations, or technological waves (e.g., the first generation of analog mobile services, the 2nd generation of digital GSM/CDMA mobile services, and the 3rd generation of WCDMA/CDMA2000 mobile standards).

![Mobile Market Matrix](adapted from [27])

The service architecture dimension of the matrix expands the integrated vs. modular dichotomy (see section 2 for theoretical background of modularity), presented by Fine [7] in his Double Helix model, by introducing an intermediate solution called “Platform”. The mobile industry is increasingly moving towards a platform approach especially in the handset and
application levels. Examples of this development are numerous, e.g. the launch of the Linux and Symbian compatible for 3G FOMA handsets by NTT DoCoMo aiming at improving time-to-market and cost effectiveness [19], and more recently the joint initiative of Renesas Technology, Fujitsu, Mitsubishi, Sharp, and NTT DoCoMo to develop a new platform for 3G mobile phone handsets targeted to the global market [20]. As these examples show, even the Japanese mobile giant NTT DoCoMo is actively trying to use more standards-based components. However, at the same time instead of using application software platforms available in the marketplace, such as Nokia’s Series 60 or the UIQ platforms, NTT DoCoMo wants to maintain control of the platform. The conclusion is that NTT DoCoMo is moving away from a closed, integrated product architecture towards a more open, platform-based product architecture while still keeping strict control over the platform specifications. Another example of this approach is the joint-venture created by Vodafone K.K. and SoftBank (which acquired Vodafone’s Japanese subsidiary in spring 2006) that will focus on developing handsets and new service platforms, and on the distribution of content [28]. From the Mobile Market Matrix point of view, this development positions the Japanese 3G business in an intermediate layer called “Platform” (see Figure 4).

Another extension to the Double Helix model [7] is the “Intermediary”, or “Hybrid”, form of industry structure, which sits between the horizontal, or the market, end of the spectrum, and vertical integrated end of the spectrum. The vertically integrated dimension does not refer only to the traditional view of an integrated company but also to various kinds of tightly-coupled, orchestrated and coordinated business networks or ecosystems. Due to space constraints we will not go deeper into logic of the Mobile Market Matrix. The point we wish to make here is that smart business networks represents one strategic option for mobile operators. As suggested by Chesbrough and Teece [4], the choice of coordination method or way of organizing service development or production depends on the type of innovation, that is, autonomous or systemic. Further, it is argued here that the stage of industry evolution plays an essential role as we will discuss in the following section. However, before moving on to the discussion about the role of industry evolution, let’s take a moment to compare the strength of mobile business networks in the two case markets.

5. The strength of mobile business networks

Frels et al. [9] have created a construct called “the strength of the network”, which consists of four components: the stand-alone product per-
formance, the user network, the complements network, and the producer network. Originally it was used in an analysis of the factors behind the success of Windows NT over UNIX operation system. Vesa [27] has used the strength of network measurement as a means to compare the Finnish and the Japanese mobile services market. The analysis is presented in Table 1 (for more details, see [27]).

<table>
<thead>
<tr>
<th>Construct</th>
<th>Japan</th>
<th>Finland</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Stand-alone product performance</td>
<td>(18)</td>
<td>(8)</td>
</tr>
<tr>
<td>- network</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>- handset</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>- services</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>- content</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>(2) User network</td>
<td>(24)</td>
<td>(16)</td>
</tr>
<tr>
<td>- current size</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>- expected future size</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>- compatibility among members</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>- accessibility of network</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>- quality of users</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>(3) Complements network</td>
<td>(23)</td>
<td>(10)</td>
</tr>
<tr>
<td>- make the focal product more productive or complete</td>
<td>23</td>
<td>(10)</td>
</tr>
<tr>
<td>(4) Producer network</td>
<td>(23)</td>
<td>(10)</td>
</tr>
<tr>
<td>- functionally equivalent to the focal product</td>
<td>23</td>
<td>(10)</td>
</tr>
<tr>
<td>- compatible with the focal product</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total score</td>
<td>88</td>
<td>44</td>
</tr>
</tbody>
</table>

Table 1 Strength of mobile services business networks in Japan and Finland [27]

What the strength of mobile networks analysis reveals is that the Japanese market is clearly in the lead in all four areas of the measurement: The stand-alone product performance (i.e., handsets, networks, applications and content) are on an excellent level; the user network on a wealthy and homogeneous market of 127 million people offers a fertile ground for new mobile services; the complements network in the form of music, film, games, consumer electronics and car industries guarantees a steady stream of complementary innovations; and finally, the producer networks of three innovative mobile operators (i.e., NTT DoCoMo, KDDI, and Vodafone K.K. / SoftBank) make sure that competition keeps the operators on the alert.
Albeit the strength of networks comparison is only preliminary and needs further development in order to make the measurement more transparent and objective, Vesa [27] argues that it gives support to “the intuitive view (based on meetings with several key players of the Japanese mobile industry in October 2002) that the Japanese mobile operators have stronger collaboration networks” than their European counterparts. Without doubt the idiosyncrasies of the Japanese economy explain large part of the country’s excellent performance in the strength of network comparison but it also shows the strength of “the Japanese way of networking” in the form of orchestrated business networks, or keiretsu. Next we will discuss the impact of industry life cycle on the evolution of business networks in the mobile services industry.

6. Industry life cycle stages and collaboration strategies

The final point this article wants to bring into the discussion of service architecture and industry structure is the question of timing. The mobile services industry represents so called “high-clockspeed industries” where industry structure and product architecture are in a constant process of change at a high velocity [7]. Therefore it is important to take into account also the impact of industry life cycle stages on this development. Figure 5 summarizes the empirical findings of the longitudinal research of the Japanese and the Finnish mobile services markets (i.e. the vertical/integrated and the horizontal/modular market configurations).
Based on the comparison of the Finnish and the Japanese mobile markets during the time period of 2002 – 2006 [e.g., 22, 25, 26, 27], it can be argued that the more integrated approach, either in the form of an integrated company or in the form of orchestrated business networks with centralized coordination, seems to be more successful during the pre-commercialization and introduction stages of the industry life cycle stages. In later stages, once various components of the mobile services system, and their interfaces become more standardized, and the users become familiar with the technology and services, a modular and market-driven mix-and-match type configuration becomes viable. However, in the Finnish mobile services market, where a horizontal and modular market configuration was introduced early on in the evolution of the mobile data services market, the market-driven approach did not manage to ensure end-to-end functionality and ease-of-use of this kind of systemic innovation. The attempts to apply the control mechanisms of the autonomous (product) innovations to a systemic (service) innovations clearly failed in the Finnish market.
7. Discussion and conclusion

The objective of this article was to raise the question whether the concept of loosely coupled business networks are applicable to the world of complex service industry such as mobile data services. Experiences from two case markets, the Finnish market with an open and modular approach, and the Japanese market with a closed and integrated market configuration, were analyzed based on earlier research on business networks, modularity, systemic innovation, and industry lifecycle. A comparative analysis of the two markets was done by using concepts such as the Mobile Market Matrix, the strength of networks analysis, and the Industry structure vs. life cycle model. These analyses provided support for the view that in the case of systemic innovation of complex services such as mobile services, the loosely coupled, modular approach may not be an optimal solution at least during the initial stages of new technologies and services. The empirical analyses presented in this article have naturally limitations, such as the peculiarities of the Japanese market vis-à-vis most European markets. However, from structural point of view the fact is that the Japanese market and the Finnish market represent almost the opposite market configurations – albeit year 2006 will be a turning point for both markets due to regulatory changes and the resulting structural changes in both marketplaces. Therefore the selection of these two case markets can be justified. It would naturally be interesting to use the same concepts in the analysis of various other markets in order to improve the generalizability of the results. Further, the measurement scales for the strength of network tool need to be developed further.

The mobile services industry, or more broadly the whole ICT industry, is going through a major transformation where traditionally closed vertical structures are challenged by flexible and dynamic network-based coordination mechanisms. Hopefully this article manages to bring new insights, such as the concepts of orchestration and strong leadership, into the discussion about smart business networks and their governance – despite the predominance of the “freedom and equality to all people” mindset of the Internet world.
References


11. Creating a Smart Business Network to enable on-line Hostel reservations

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Abstract

This paper presents a case study of an Irish SME – Web Reservations International (WRI) - who has successfully created a profitable smart business network. The case details how the firm succeeded in creating a virtual marketplace, in which it remains central, by using web technology to service a hitherto unserviced market – on-line booking of hostel rooms. Through an extensive web-based business network which includes a broad array of self-run web sites, partnerships with complimentary travel web sites and revenue sharing agreements with tour/activity providers WRI has now become the biggest global provider of confirmed online reservations for the budget accommodation sector.

Case Study

In 1999 Ray Nolan and Tom Kennedy founded privately owned Web Reservations International and created an online reservation site for hostel bookings - www.hostelworld.com. In January 2003 WRI acquired hostels.com and followed this by purchasing Hostels of Europe in early 2004. The company is now the biggest global provider of confirmed online reservations for the budget accommodation sector.

The mission and vision of Hostelworld.com is:
“..to provide on-line confirmed bookings for hostels, budget accommodation centres and package tours, as well as comprehensive content such as city and country guides.”
Background Information

Increasingly, the trend among travellers is to bypass traditional channels to organise holiday and business travel, particularly in the US market, where online travel booking revenue was worth $46 Billion in 2003 or 20 per cent of the total US travel revenue. Some industry analysts forecast to grow to $91 Billion or 33 per cent of total US travel revenue by 2009 as more travellers use online booking systems and as direct suppliers and third party organizations vie for customers.

Interestingly the proportion of these international tourists which are young travellers (15-24 year olds) grew from 14.6% in 1980 to 20% in 2001 and the share is forecast to reach 25% by 2005. (www.world-tourism.org). The BYIT market comprises of students, youths, backpackers and independent travellers. They typically are web-savvy, value conscious and tend to take extended vacations and set the travel trends for the business travellers of the future. Nolan (2002) describes this market “…as the most web-friendly segment of the market. Web Reservations International is already the leader in technology and booking revenue in this market and we intend to grow even faster in the future.”

Online travel companies because of the low prices, low commission and margins and the high cost of traditional booking systems have neglected the BYIT sector. These traditional booking systems, called Global Distribution Systems (GDS), provide pre-Internet travel booking systems. However, the high cost of installing and using GDS systems makes them unsuitable for both BYIT product providers and travel companies. In comparison, WRI’s online booking system provides a web only, low cost booking system, effectively becoming the GDS of the BYIT sector.

According to Nolan: “Budget tourism was totally by-passed by technology until we came along”. It was not serviced online before we existed. We created the industry.” In the early 1990s the 15,000 hostels worldwide generally ran their own individual websites, with no credit care booking facilities. Typically hostel users may spend less per night but go away for longer periods of time and therefore spend more money than average travellers. By 2003 WRI had built relationships with 5,000 hostels and was selling rooms on their behalf through an integrated Internet reservation system. This grew to 8,000 by 2004.
The Product and Websites

The core product offered to individual hostels is Backpack – a reservation management system for the youth hostels and budget accommodation. The software is designed to run on PC’s running Microsoft Windows. Each hostel installs the software onto their PC and through a modem connection it integrates fully with WRI websites which allows hostel owners to upload availability and download bookings. In addition, the software provides a complete bed management system with functionality which includes the ability to browse for availability, search for guests, review pending arrivals and set room accommodation allocations. Financial functionality is also included which allows the viewing and printing of invoices, letters and vouchers and the generation of over 40 different reports that assist in the management of the accommodation centre. These reports include end of shift payment analysis, bookings by booking source, income analysis, stock analysis and credit card pre-authorisation.

WRI main site – www.hosteworld.com - allows visitors to choose a destination or hostel, select an arrival date and the duration of their stay and quotes prices in whichever currency they wish to use making the booking procedure extremely straightforward. Once a hostel has been selected, detailed information is available on the hostels location, photographs of the exterior and interior, a currency converter, room reviews and all other relevant information for the chosen accommodation, (see Exhibit 1).
Exhibit 1 Hostelworld.com Reservation Details

As well as the booking facility, WRI provide guides to the various continents, countries and cities where hostels are located. City guides provide lists of pubs, clubs, attractions, and provide an interactive map to locate each one and contain information on transport, weather, opening hours, public holidays, tourist offices etc. In essence WRI websites provide all the necessary information travellers need to know before booking accommodation.

WRI’s best know and flagship website www.hostelworld.com is aimed at the backpacker and student market and attracts over 12 million visitors annually. However, this is not the company’s only site. It also operates and runs a number of hostel sites for city, country and continent sites, such hosteldublin.com, hosteleurope.com. Another website is trav.com which offers budget accommodation, tours, activities, transport, travel insurance and ancillary products for the BYIT market. Things2do.com a recent addition to WRI provides online booking and information for adventure activities, sightseeing tours, events and transport as well as accommodation including hostels, budget hotels and guesthouses. Linked to the BYIT market focus WRI runs www.insureandtravel.com that sells online insurance poli-
Creating a Smart Business Network to enable on-line Hostel reservations

WRI runs 500 websites targeted at BIYT market (see Exhibit 2). The online service confirms online reservations for budget accommodation and other complementary travel products.

**Flagship Websites**
- www.hostelworld.com
- www.trav.com
- www.things2do.com
- www.discounthotels-world.com
- www.insureandtravel.com
- www.hostels.com

**Exhibit 2: Sample of WRI Websites** (Source: WRI)

The purpose of having 500 individual sites is to ensure that anybody searching for a hostel will ultimately land on a WRI site. The success of this strategy can be seen in the fact that sites controlled by WRI dominate any Google search for hostel accommodation in any major town or city in the world. This Internet based marketing strategy is consistent with the emphasis of being a low cost operator. WRI uses search engine optimisation and they present the same information in different format depending on the website. So if a online users is were looking for hostel accommodation in South Africa, a search engine might direct you to any one of four sites that they own, namely, Hosteljohanesburg.com, hostel-southafrica.com and hostelafrica.com

In 2003, WRI generated more than 3 million bed/night bookings and attracted over 30 millions visitors to its various websites. Fifty per cent of the WRIs revenue is generated from its own websites.

In pursing its dominance of the BYIT market WRI licences its reservation technology to a wide range of affiliate travel websites (Exhibit 3).
Affiliate Licenses
www.studentuniverse.com
www.lonelyplanet.com
www.ryanair.com
www.flybe.com
www.letsgo.com
www.raileurope.com
www.kasbah.com
www.ebookers.com

Exhibit 3 Sample of WRI Affiliate Licences (Source: WRI)

The number of affiliates using WRI’s online booking technology reached 700 by early 2004. WRI has targeted the travel agent market overlooked by many industry players in the dot.com rush. WRI have established a Travel Agent Extranet System for this market coupled with a loyalty card. As Kennedy states: "We have developed the software to benefit travel agents and affiliates such as Rough Guide and Time Out, which can offer a worldwide reach to accommodation and share in the commission we can generate."

WRI’s also provides a facility for tour/activity providers which allows them advertise their offerings and allows customer to book them online. WRI reservation system is being used by customers to book not just their hostel room, but also other elements of their holiday. Such activities may include museum tickets, exhibitions, city tours, bungee jumping, rafting, abseiling, skydiving etc (see Exhibit 4).
11. Creating a Smart Business Network to enable on-line Hostel reservations

Exhibit 4  Example of Tour/Activity Provider Information: Bus Tour of Rome

For example, Nolan (2003) states that ‘some 40% of people booking a Dublin stay through a WRI site also book Aircoach tickets.’ WRI takes an annual fee ($500 per year for one listing, $800 per year for two to four listings and $1,000 for 5+ tours) and 10 per cent reservation fee from tour operators for complementary products they sell through its websites.

The Revenue Model/ Income

“WRI’s model is simple: it handles hostel bookings through a huge network of websites, and makes its money by holding onto the deposit paid for the accommodation” (Nolan, 2004). When using WRI’s websites travellers are told immediately if a hostel has space, which they can then book and reserve right away by having a 10 per cent deposit and small booking fee charged to a credit card. WRI offers the rooms at the price the hostel charges, making its money by keeping the 10 per cent charge and the fee.
The margins may be very small on a typical €10 hostel bed, but with 8,000 hostels in nearly 160 countries and 460 cities, WRI does very well on volume. WRI have not altered the revenue model for industry participants, but have provided a dominant electronic market forum for this international market. Coupled with international coverage as Nolan (2003) describes, “When we sell a ticket, we are automatically out of the game and because we have hostels in both the southern and the northern hemispheres, we don’t have a slow season” This has resulted in profits of 400 per cent in 2003 with forecasts for similar performances in the next four years. Central to this is WRI’s ability to keep the cost base low and communications to a minimum. The business is entirely Internet based, and the premise is that if an employee has to lay a finger on a booking, WRI loses money. Given this premise and the increase in sales volume since 2000, the cost of making €1 revenue has fallen from €2.56 to 41 cent.
12. Business Agility Implications for Smart Business Networks

Marcel van Oosterhout, Eric van Heck, Eric Waarts\textsuperscript{11}, Jos van Hillegersberg\textsuperscript{12}

Abstract

The current highly dynamic business environment increasingly requires businesses to be agile. Business agility is defined as the ability of a business to sense highly uncertain external and internal circumstances, and respond in a proper way, either reactively or proactively, based on innovation of the internal operational processes, involving the customer in exploration and exploitation activities, while leveraging the capabilities of partners in the business network. In this article we argue that business agility is an important enabling strategy for Smart Business Networks (SBN), which determines the performance of participants in the SBN and therefore the performance of the SBN itself. This paper analyzes from a theoretical and practical point of view the role and impact of IT on business agility and business (network) performance. We discuss the results of two multi-method field studies conducted in four business segments and three public segments. The results of these studies show that business networks have a high need for business agility for a variety of uncertain circumstances. We discuss some empirical evidence of the emergence of SBNs within the Dutch telecom and energy sectors. Finally, implications for Smart Business Networks are drawn. We propose a conceptual model and measuring items to analyze the factors which affect business network performance: alignment, orchestration and design architecture.

Keywords smart business networks, agility, performance, IT architecture, IT infrastructure, IT agility, alignment, design, orchestration

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Introduction

For a long time business environments were rather stable. In these stable environments there was little urgency to be adaptive and respond with speed to internal or external changes. However, two primary forces, technology innovation and long-term public policy shifts destabilized the business landscape and will reshape the world we live in (Hagel and Brown, 2003). The globalized world of the 21st century has become flat (Friedman, 2005). In this flattened world organizations need to respond to or even anticipate changes which are uncertain and in some cases even unpredictable (Sharifi & Zhang, 1999). Such changes require organizations to be agile, which can be defined as the ability to thrive in a competitive environment of continuous and unanticipated change and to respond quickly to rapidly changing, fragmenting global markets that are served by networked competitors with routine access to a worldwide production system and are driven by demand for high-quality, high-performance, low-cost, customer-configured products and services (Goldman et al, 1995).

To deal with the increasing level of turbulence in the environment there is a development where traditional organizational architectures and horizontal supply chains are moving into spontaneous agile collaborative networks (Konsynski & Tiwana, 2004) or virtual enterprises (Aerts et al, 2002). IT provides the necessary connectivity for such networks. Partners are linked together (temporary) to fulfil a specific product or even order (Christopher & Towill, 2000). In the most dynamic constellation, we talk about extreme integration, where 'applications integrate with each other on a dynamic basis by discovering their partners on the fly and then integrate them on as-needed basis’ (Umar, 2005: 248). Hagel & Brown (2005) describe accelerated capability building as the dynamic new source of competitive advantage. Companies can build a sustainable edge based on three dimensions: dynamic specialization of internal capabilities, mobilizing the resources of other specialized companies on the basis of connectivity and coordination (via outsourcing and off shoring) and accelerated learning across broad networks of enterprises. This includes the transformation of knowledge into capabilities, which are embodied in products and services. Gulatti & Kletter (2005) call this the relationship-centred organization, where organizations manage their costs through shrinking the core (internal capabilities) while enhancing revenue streams through expanding their periphery (by mobilizing partners’ capabilities). These spontaneous agile collaborative networks are called Smart Business Networks (Vervest et al, 2005). They define a smart business network (SBN) as “a group of partici-
pating businesses – organizational entities or actors – that form the nodes, linked together via one or more communication networks forming the links or lines between the nodes with compatible goals interacting in novel ways, perceived by each participant as increasing its own value, sustainable over time as a network”. We argue that business agility is an important enabling strategy for SBN, which determines the performance of participants in the SBN and therefore the performance of the SBN itself.

The importance of SBN and the required level of agility in today’s turbulent business landscape justify a study on business agility, its components and its effects on organizations and business networks. As was clearly shown in a panel discussion on "the agile enterprise" at MIT's CIO Summit (Schrage, 2004), there is by far no consensus as to what exactly agility is, nor on how one could assess and achieve agility. Very few studies have attempted to empirically study the need for agility, the way organizations are reacting and the role of IT. What are uncertain circumstances requiring organizations and business networks to be agile, what is the relative importance of these factors and how can IT be used as enabling platform for agility and adaptation? Furthermore, under which conditions will SBN work? We will explore the business agility implications for the orchestration and design of SBN. Finally, we will propose a conceptual model to relate business agility to the performance of business networks.

We have analyzed agility aspects in two field studies in seven sectors in the Netherlands. The results are also interesting for agility of the SBN and the relation with performance. Our research questions are the following:

- Which factors determine business agility need for organizations and business networks.
- How do these factors lead to the emergence of smart business networks.
- Under which conditions will SBN’s work and which lessons can be drawn with regards to the design and orchestration of the SBN?

The article flows as follows. In section 2 the concept of business agility is introduced. In section 3 the results of two studies on business agility need and readiness on organizational level are discussed. In section 4 two examples of the emergence of smart business networks in the Dutch telecom and energy sectors are analyzed. In section 5 a conceptual framework is proposed to analyze the factors affecting business network performance. Implications for the design and orchestration of the SBN are elaborated. Section 6 provides conclusions and some research issues and challenges in this field.
Business Agility

The concept of agility originated at the end of the eighties and in the early nineties in the manufacturing area in the USA. Agile Manufacturing was first introduced with the publication of a report entitled 21st Century Manufacturing Enterprise Strategy (Goldman et al, 1991). Agile manufacturing was introduced as a new manufacturing paradigm, as a way to deal with changes in customer requirements by agile responsive manufacturing concepts. This was followed by a series of publications on agile manufacturing and agile corporations (Kidd, 1994; Goldman et al, 1995; Dove, 2001; Lee, 2004). The concept was extended to supply chains and business networks (Mason-Jones and Towill, 1999; Van Hoek et al, 2001; Swafford, 2003; Yusuf et al, 2004).

Agility can be implemented either pro-actively (leading or initiating a change – placing organizations in a leadership position) or reactively (responding to change, either opportunistic or degenerative in order to retain competitiveness). Agility requirements can be found on 3 levels: strategic, tactical or operational. Reconfiguring a business model (which triggers a horizontal change in the business network) is an example of strategic agility. Quickly (dis)connecting a partner for collaborating (which triggers a vertical change in the business network) is an example of tactical agility. Reconfiguring a specific business rule in the operational process to comply with new legislation is an example of operational agility. Agility requirements demand a change of the organization and its business network. The scope of the change can be a change within the existing structure (mainly operational and tactical agility requirements) or a reconfiguration into a new structure (mainly strategic agility requirements).

At the heart of agility is the concept of speed – the capability of an organization to rapidly execute decision making, operational cycles and reconfiguration of corporate structures (Conner, 2000). An agile response is innovative, rather than pre-engineered. Moreover, it is important to note that agility is relevant on two different levels: the enterprise level and the SBN level. These two levels naturally interact. Business agility is dynamic and context specific (in time and space). What is presumed to be agile today can be non-agile tomorrow (Conner, 2000).

The definitions on agility mention the importance three types of capabilities (Bradley & Nolan, 1998; Dove, 2001). The first capability needed is sensing, which is about detecting and anticipating. An example of a sense capability is the choice of enabling/emerging technologies (ET) and matching these ET with economic opportunities or discontinuities in the product-market space (Eisenhardt and Martin, 2000). The second capability is responding, which can be defined as the physical ability to quickly
and relatively ease reconfigure and implement changes in the organization and the business network. A third business agility capability is learning, which includes the transfer of data into information, information into knowledge and knowledge into capabilities, which are embodied in products and services. Overby et al (2006) point at the symbiotic relationship between the three capabilities. A strong sensing capability may be wasted if a firm lacks the ability to respond to identified opportunities. Similarly, a strong response capability may not help a firm if it is unable to identify opportunities on which to act. Furthermore, without learning sense and respond cannot improve in time.

Business agility capabilities can be executed by the internal organization or co-sourced or outsourced to business partners or even the customer (Hagel & Brown, 2005). In this respect Sambamurthy et al (2003) distinguish between internal or operational agility, partnering agility and customer agility. This distinction is in line with types of strategic agility as defined by Weill et al (2002). To summarize, we define Business Agility as the ability of a business to sense highly uncertain external and internal circumstances, and respond in a proper way, either reactively or proactively, based on innovation of the internal operational processes, involving the customer in exploration and exploitation activities, while leveraging the capabilities of partners in the business network. Empirical research will need to focus on the measurement of the impact of business agility on business performance, business network performance and empirical validation of the relationship between these constructs.

Business Agility Need and Readiness

Introduction and methodology field studies

We will now shortly discuss the results of two field studies conducted in 2004 and 2005, which were focused on assessment of business agility need, business agility readiness and agility gaps. Since our research encompassed different kinds of research questions, different research methods were used (Ying, 1994). Both method triangulation (surveys and case studies in two field studies) and respondent triangulation (both IT managers and business managers) was applied to create a more comprehensive and valid picture on business agility within organizations (Mingers, 2001). Using multiple methods adds to the richness and validity of the results. The case studies sacrifice breadth for depth, while the surveys enable us to draw more generalizable conclusions.

The first study in 2004 consisted of a web survey among 37 respondents and 21 follow-up case studies in four business segments (Van Oosterhout
47 managers and experts were interviewed and internal documents were analyzed. Sectors analyzed were retail banking, mobile telecom, energy and logistic service providers. Questions in the survey and interviews dealt with external and internal circumstances requiring business agility, perceived gaps, the role of the IT architecture and IT infrastructure. The second study in 2005 consisted of a survey among 73 respondents and 10 follow-up case studies in 3 public segments (Van Oosterhout et al., 2006b). 18 managers in the sectors central government, higher education and operational authorities (like tax authorities) were interviewed. The same type of questions were used as in the first study, however they were slightly modified for the public setting.

**Results**

The two studies show that some change factors requiring agility are generic, but some are dependent on public or private domains. The emerging price war and the need for lower prices products & services combined with fast changing customer requests is dramatically influencing all business sectors analyzed. Companies have a lot of difficulties coping with the required changes in their internal processes. Lowering the prices requires changes in operational processes and systems to cut costs. This is an important driver for re-organizing the internal processes and major organizational change. Many respondents mentioned the case of mergers and acquisitions - as an example of major organizational change – where merging and integrating the various IT infrastructures was most time consuming and caused the largest gaps. Some of the deeper reasons behind the agility gaps in the operational agility capability can be found in the fact that implementing changing requirements into the organization and IT systems takes too long. Many respondents indicated that in many legacy systems business rules are embedded. There is no distinction between, data, applications and business rules, which hampers agility readiness. Since increasingly time and money is spent on maintenance and support of the existing IT infrastructure, insufficient budget remains for investing in innovation and creating options for a more agility enhancing architecture.

Within the public sectors managers perceive large agility gaps for Digitization of documents and the usage of e-signatures and Expertise of employees. Digitalization of documents and signatures plays an important role to streamline policy decision-making and transactions between citizens and government agencies, but has far reaching impacts on the whole workflow throughout and between organizations. The information society and changing role of the public sector requires other types of expertise. Main factors hindering agility which came out of the interviews were the aging workforce, insufficient change oriented people and a loss of exper-
Business Agility Implications for Smart Business Networks

Additionally, new regulation is causing a high need for business agility in almost all sectors analyzed. Executives in all sectors researched perceive a high effect- and response uncertainty with regards to government regulation measures. The amount of new regulation, the problem of lack of implementation details and the timing makes it necessary to implement the required changes in a short time-frame.

Furthermore, various change factors are sector specific. Given the differences between different sectors on the relative scores for change factors on need and readiness, sector specific benchmarks are needed for organizations to assess and compare their scores on various change factors.

The results also indicate that the need for business agility is not just created by uncertainty about external changes. Many internal changes (like mergers and acquisitions, changes in systems and procedures, digitalization of documents and e-signatures) require organizations to increase their readiness.

Business Agility readiness in general is organization specific, although the same type of challenges in increasing business agility IT capabilities are found in all organizations analyzed. Most of them were large organizations. Respondents are very worried about the pace at which responses to the changes can be implemented. To a large degree this can be explained by the existing organizational structures, cultures and legacy infrastructures.

Empirical examples of Smart Business Networks

Introduction
Although our two field studies were primary focused on the organizational level of analyses, questions in the survey and during the interviews were included to assess the role of the business network. Management pays relatively limited attention to the business network dimension. Far more attention is given to internal reorganizations, due to cost cutting programs, consolidations, mergers and acquisitions. An important element in these restructurings is the consolidation and centralization of IT and the transformation of monolithic IT architectures to more open IT-architectures (for instance Service Oriented Architectures). The increasing costs for maintenance of the existing IT infrastructure hinder business agility, since insufficient budget remains to innovate via IT.

However, a number of observations in our field studies point at the increasing importance of the business network. Some findings from our field
studies support this. Managers perceive a relatively high need for switching between different suppliers of products and services. However, perceived readiness is low. What is interesting to note is that although the need for switching increases, this appears to be relevant only for a limited number of partners. The need for agility to deal with increasing number of partnerships scores relative low, with the exception of the telecom sector. Most large organizations have the role of central node in the business network, while collaborating with a (relative small) number of partners for specific services or outsourced tasks like IT support, call centers or transport services. Outsourcing and off-shoring so far mainly focus on IT support and IT development capabilities, which cause the highest gaps within Finance and Other Public. Most business networks can be considered to be relatively stable. The telecom and energy sectors are most dynamic with regards to (changes in) variety and number of partners and changes in the business network architecture. In the next section we analyze how SBN’s are emerging in these sectors over the past ten years.

**Telecom sector**

Within the telecom sector globalization, deregulation, digitalization and increasing connectivity have reshaped the architecture of the business network. Figure 1 provides an overview of the Dutch telecom network in 1996. This was characterized as a relatively stable network with a few parties, delivering a few products and services. All arrows represent interconnectivity on the basis of web-interfaces, web-services or standardized EDI and XML message exchange. Some examples of organizations (logos) are included. Of course, this is just a simplified version of the real business network architecture.
In ten years time the business network has become dynamic with many (new) parties offering new products and services (Figure 2). The trend of unbundling of products and services (driven by the deregulation of the market) and the increasing interconnectivity (enabled by IT) is reshaping the business network architecture. On the one hand there is a trend of blurring of industry boundaries (finance, media, telecom and IT are merging) (Bradley and Nolan, 1998). On the other hand re-intermediation creates new actors with new capabilities, providing new services to the final customers. Relationship-centred organizations (RCO’s) are active, who only focus on marketing and sales of telecom products and services to the final customer. Examples are large retailers with their own mobility brand (AH Mobile) and media companies targeting the youth segments (Free Mobile, ID&T). All other products and services are mobilized from other partners in the business network, like usage of the communication network, products (mobile devices, digital content) and services (like financial services). IT- and outsourcing partners increasingly provide IT services, back-office operations and call centre processes.

Besides RCO’s there is also an increasing role for web portals. On the one hand there are web portals, which provide search-, compare- and buy capabilities. In most cases these are only aimed at the first phase in the product-service transaction cycle (initial sales). Furthermore, entertainment portals provide digital content to customers, which can be accessed...
via mobile devices. Cooperation and central orchestration is found in various areas, e.g. in sharing infrastructures, joint development of standards and network roaming (e.g. via the Freemove partnership). Telecom operators are migrating to become entertainment and media companies.

![Telecom Business Network Architecture in the Netherlands (2006)](image)

**Figure 2** Telecom Business Network Architecture in the Netherlands (2006)

An important agility requirement is dealing with shortening of competitors' time to market of new products and services. There is a high pressure to bring new products and services onto the market within a short timeframe. For instance, the introduction of new mobile payment models, data services, new content concepts based on increased bandwidth or new location based services require fundamental changes in the organizations procedures, systems and partnerships.

Respondents perceive a high business agility need within telecom. Competition is moving from the organization to the SBN. We propose that the SBN which is most agile in smart innovations in products, services and SBN coordination will achieve the best performance.
Energy sector

Figure 3 provides an overview of the business network of the Dutch energy sector in 1996. This was characterized as a rather stable network with a lot of regional governmental energy distribution organizations.

In ten years time the Dutch business network of the energy sector has changed to a more dynamic business network (Figure 4). The merging of local energy distributors into three national energy distributors who serve the majority of the market is clearly visible. Furthermore, the liberalization of the market has reshaped the architecture of the business network considerably. The trends of unbundling of products and services (driven by the deregulation of the market) and the increasing interconnectivity (enabled by IT) are reshaping the business network architecture. Especially the (intended) separation of distribution and marketing and delivery of energy products will cause a high need for agility and major organizational changes. Relationship-centred organizations (RCO’s) are active, who only focus on marketing and sales of energy products and services to the final customer. Examples are RCO’s who are specialized in providing green energy products, while all other capabilities are mobilized from other part-
ners in the business network, like usage of the energy distribution networks and metering services. However, so far this only constitutes a very small share of the market. IT- and outsourcing partners increasingly provide IT services, back-office operations and call centre processes, which are needed to make energy distributors more agile and customer oriented. Besides RCO’s there is a modest role for web portals, which provide search-, compare- and buy capabilities. In most cases these are only aimed at the first phase in the product-service transaction cycle (initial sales).

![Energy Business Network Architecture in the Netherlands (2006)](image)

**Figure 4** Energy Business Network Architecture in the Netherlands (2006)

There are a number of initiatives and facilitators for connectivity and orchestration of the business network. In 1999 the Amsterdam Power Exchange (APX) was founded to trade in electricity as a facilitator for the liberalisation of the market. TenneT is the independent and impartial market facilitator in the liberalized energy market. With its high-grade transmission grid and customized services it markets and develops a comprehensive range of transmission and system services as well as supplying services aimed at boosting the market mechanism and encouraging the development of a sustainable energy supply system. TenneT provides the transmission and interconnectivity towards (foreign) producers and among national distributors. A number of energy companies have set up the En-
nergy Clearing House, to support easy switching of customers between energy distributors, energy providers and measurement companies.

To summarize, there is clear trend and growing importance for the SBN. The trends as described by Hagel and Brown and Gulatti are visible, but so far constitute a small part of the total Dutch market in the sectors telecom and energy.

**Implications for Smart Business Networks**

*Conceptual framework to analyze SBN performance*

The results of our field studies confirm the importance of the business network. More insight is needed into the factors which affect the performance of the business network. Based on the results of the first two field studies and further literature research we propose a conceptual framework to analyze business network performance for smart business networks (see Figure 5). We propose business network performance is determined by three interrelated factors: alignment, orchestration and design architecture (adapted from Konsynski and Tiwana, 2004).

![Figure 5 Conceptual framework for analyzing the factors which determine SBN performance](image)

Business agility and IT agility need continuous alignment. Alignment is needed between organizational and information systems infrastructures (Henderson and Venkatraman, 1993). Organizational design translates business strategy into organizational infrastructure, while IS design translates IT strategy into IS infrastructure. These design activities are interdependent. Alignment is a process of continuous adaptation and change. Bergeron et al (2004) propose that conflicting co-alignment patterns of business strategy, business structure, IT strategy and IT structure will exhibit lower levels of business performance. The weakest partner in the SBN more or less determines the maximum possible performance of the
SBN. Therefore business agility and IT agility levels of SBN participants need to be aligned to enhance business network performance.

Orchestration of the SBN includes sensing (monitoring of performance), responding (reacting - pro-active or reactive-to uncertain circumstances and to partners’ performance) and facilitation of learning among the SBN participants. If SBN performance does not match required performance, this can lead to a redefinition of business strategy and/or IT Strategy for the participants in the SBN whose performance is insufficient. The orchestrator of the SBN might even decide to select other partners who can meet the performance requirements. Furthermore, a central orchestration of standards is an important element in the orchestration of the SBN. If central orchestration is missing, implementing changes takes more time and is more costly (especially for changes with a wide scope e.g. involving multiple organizations or units). A centralized network orchestration of standards enhanced agility of the business network in our field studies.

The performance of the SBN is determined to a large extend by its design of products, services, (inter-organizational) processes and coordination. Since IT is the enabling technology for the connectivity and smartness of the SBN, the degree of agile IT is an important element in the design of a SBN. We define agile IT as *the degree in which the design of the IT architecture and the (governance of) the IT infrastructure of (participants in) the SBN support immediate adaptation and response.*

The performance of the business network more or less is the sum of the performances of the SBN participants. The performance of each participant can be measured by analyzing the reaction capability to an uncertain circumstance, for instance bringing a new product to the market, implementing a new government regulation or changing to a new business model. Both direct and indirect effects of business agility and IT agility on business performance can be distinguished. Although IT may have direct effects on performance in certain circumstances, a large part of the business value of IT stems from its complementarities with business processes and capabilities (Overby et al, 2006). The direct or first-order effects of business agility and IT agility on business performance can be assessed via four change proficiency metrics (Dove, 2001): response time (lead time), response cost, response quality (or robustness) and response scope (the magnitude of change which can be accommodated i.e. variety). Business networks which are more agile will respond to a circumstance in a shorter timeframe, at a lower cost with a wider scope, while maintaining robustness (compared to less agile competing business networks). Second-order effects on business performance are competitive outcomes and incorporate the influence of external factors such as competitors’ moves and environmental changes beyond the control of the (individual firm within the) SBN.
Examples of indirect or second-order effects are improvements in business efficiency, generating new revenue streams (for instance by mobilizing capabilities of business partners, which were previously considered as inaccessible (Schmelzer, 2006)) and reduced time to market, which leads to extra revenues (first mover advantages).

The orchestration and design of IT are important elements of SBN’s connectivity (providing the links) and novel interaction (providing the smartness). In the next sections we will subsequently analyze the orchestration and design factors, which determine the agility of the SBN and its performance.

**Orchestrating the SBN**

Orchestration of (parts of) the SBN is done by one or more network orchestrators. The sensing, responding and learning capabilities also apply as important capabilities for the SBN orchestrator. This role can be taken by one of the parties in the SBN (usually one of the nodes), a neutral third party (like an IT broker) or the collective participants in the SBN (supported by a Business Operating System). Based on our two field studies and some further literature research we have developed a set of nine factors which affect the orchestration or governance of the SBN as a whole and the individual SBN participants (see Table 1). Our proposition is that the more factors are incorporated in the orchestration of the SBN, the more agile the SBN will be, which will results in a better performance.

Besides (IT) connectivity shared standards are needed to exchange information and collaborate on business network level. Examples as applied in our field studies are standards for (e)payment (finance), financial reporting (finance), transport, status and tracking and tracing messages (logistics), customer switching (energy), student registrations (higher education), authentication of citizens and businesses (public sector). Furthermore, shared IT infrastructures are used for payment and settlement (finance), community systems (logistics), network roaming (telecom), switching (energy) and public services.

Besides organizations who are directly involved in the operational processes to deliver a product or service to the customer, there are also some examples in our field studies of neutral third parties who take an orchestrating role in (part of) the SBN. Within logistics centralized web-based platforms for trade, transactions and coordination like port community systems and global booking portals for shipping lines orchestrate part of the processes in the business network. In the energy sector a number of energy companies set up the Energy Clearing House, to support easy switching of customers from one company to another. In Higher Education a centralized web-registry for student registrations with connections to IBG (providing
student loans) and universities is set up. In the public sector a number of organizations (amongst which the tax office) are working on a centralized web-portal for Governmental Services. Increasingly (independent) IT providers provide a broker role in business networks. They provide mid office architectures, to bridge front office applications with (SBN partners') back office systems and applications, usually on the basis of web services. Some examples of such architectures\(^{13}\) currently are under development in the public sector.

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<th>Items</th>
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<tr>
<td>Sense</td>
<td>Using sensing and alert tools</td>
<td>2. Daft et al, 1998; Conner, 2000</td>
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<td>Learn</td>
<td>Staged investments in IT infrastructure</td>
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\(^{13}\) For an example we refer to the Midoffice architecture, provided by IT provider Centric to local governments, which provides business process management and translation tools between front office applications and back office systems. See: http://www.centriccity.nl/
The concept of the Business Operating System (BOS) receives attention as governance mechanism for responsive business networks (Vervest et al., 2005). A BOS can be described as a system which coordinates the processes among the networked businesses, while its logic is embedded in the systems used by these businesses. The BOS can take many forms and is based on a combination of different technologies and advances in IT architectures, like agent technologies, Business Process Management Tools and embedded intelligence in state of the art communication networks. BOS form the glue or the logic that connect different partners in the network. BOS are one of the means of a SBN to enhance its respond capabilities. Some manifestations of BOS in our field studies are the usage of logic embedded in the communication network (in telecom)) and the usage of RFID tagging and sensors to increase transparency and visibility (in logistics).

Another more simple solution to orchestrate communication among networked business is the web collaboration space, which is used to support globally dispersed project teams. In all sectors organizations and project teams are using such tools. Although relatively easy to set up, these tools can enhance agility of the business network to deal with uncertain circumstances by enhancing transparency and centralized access to information. Both centralized solutions (like Microsoft Sharepoint) as well as distributed peer to peer solutions (like Groove workspace) are possible, both with their pro’s and con’s.

Designing the SBN

The agility of the SBN is determined to a large extend by its design of products, services, processes and the degree of agile IT. Based on our two field studies and some further literature research we have developed a set of thirteen design factors which affect the performance of the SBN as a whole and the individual SBN participants (see Table 2). Our proposition is that the more factors are incorporated in the design of services, processes and IT architecture, the more agile the SBN will be, which will results in a better performance.

Several Consultancies and IT vendors like IBM, HP and CapGemini have made it their key strategy to help organizations to achieve IT agility. A lot of books and articles have been written on the agile responsive organization, that can configure its resources and people quickly and which is flexible enough to sense and respond to changing demands, enabled by IS in general and the Internet in particular (Pearlson & Sanders, 2006). Previous research provided evidence for a positive relationship between flexible IT infrastructure and competitive advantage (Byrd and Turner, 2001). An enabling IT infrastructure permits as-yet unspecified business strategies to be implemented rapidly i.e. supports business agility (Weil
Table 2. Design factors for the agile SBN

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<td>7.</td>
<td>Sharability of (IT) resources</td>
<td>g) Boden (2004)</td>
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<td>9.</td>
<td>Reusability of (IT) resources</td>
<td>i) Dove (2005)</td>
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<tr>
<td>12.</td>
<td>Distributed access to information (high visibility)</td>
<td>l) Konsynski &amp; Tiwana (2004); Evgeniou (2002)</td>
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<tr>
<td>13.</td>
<td>Involvement of customers in product development and service delivery</td>
<td>m) Van Hoek et al (2001); Maskell (2001)</td>
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and Broadbent, 1998). However, other studies provide evidence for the negative effects of IT on responsiveness and business agility (Attaran, 2004; van Oosterhout et al, 2006a). Main reasons for these negative effects are inflexible and hard-wired IT architectures, a lack of integration between business and IT (i.e. insufficient Business-IT alignment) and differences in views between business and IT leaders on the importance of IT
and the timing of adoption of new technology (Kearney, 2005; Hagel and Brown, 2003; Prahalad et al, 2002).

The degree of IT agility depends to a large degree on the stage of the IT architecture. Aerts et al (2004) provide an outline of the historical development of IT architecture. Complex and large organizations have multiple architectures, which can be in different stages of development. In general, more traditional architectures are used in stable environments, where performance and stability is favoured over flexibility and agility. Connecting the different partners in the SBN with IT systems in a different stage of their life cycle poses an important challenge for SBN’s. Middleware technologies and brokers can play an important role in facilitating the required connectivity.

Conclusions and research challenges

Business agility is an important strategy for organizations and business networks to deal with uncertain circumstances. Organizations within Smart Business Networks need a high level of IT agility to achieve the required level of responsiveness and performance in today’s turbulent environment. In our field studies in different sectors a clear trend was visible, where linear supply chains are migrating to more dynamic and agile business networks. IT provides the necessary connectivity to enable the unbundling of products and services and the (dynamic) mobilization of capabilities from partners in the SBN. Furthermore, IT creates opportunities for novel interaction and smartness in sensing, responding and learning among the SBN partners. Although the opportunities of IT are large, most business executives in our studies still perceive IT to be an inhibitor for change. Legacy systems and high costs for systems maintenance and support constrain agility. Management attention is focused on making the internal organization more efficient by consolidation and standardization of IT(infrastructure). However, the foundations for increased levels of business agility are effectuated via enhancement of IT agility via more open and agile IT architectures. The type of agility required and the role of IT agility attributes will differ, depending on the type of industry and the degree of dynamism in the network.

We have developed a conceptual model to analyze business network performance for smart business networks. We propose business network performance is determined by three interrelated factors: alignment, orchestration and design architecture. We will need to operationalize the various constructs of our conceptual model and conduct a number of longitudinal case studies for a first validation. We have developed a number of meas-
uring items for the various constructs of our conceptual model. These items can form the basis for a measurement instrument which can support SBN orchestrators in the design and orchestration of the SBN, especially with regards to governance and design of IT.

Analyzing the effects of agile IT on business (network) performance is a challenging task. How to measure business network performance and what is the relation between individual SBN actors’ performance and SBN performance? Finally, how can IT agility be related to business agility? In most organizations detailed business cases are made before investment in (agile) IT are made. However, once the investment decision has been made only actual costs are monitored, while the effects (on performance) are hardly measured. Furthermore, how can the effects of IT agility on (business network) performance be separated from other independent variables like competitors’ moves, changes in organization structure etc. This makes a longitudinal study based on objective measurements difficult. We propose to combine both objective and subjective measures to assess the relationships of our conceptual model and do measurements on organizational level. One of the case studies we will conduct will be a field experiment, where the effects of agile IT (i.e. a grid technology solution) on business agility, business performance and business network performance will be investigated. This study is at the moment in progress. In this study a pre-and post measurement will be conducted to analyze the effects of a grid technology architecture on the performance of different partners in the business network under extreme uncertain circumstances.

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Report Parallel Session A

Reporter: Marcel van Oosterhout


Presenter: Harry Jarn (Nokia)

Harry Jarn presents the state of the art on developments in Telecommunications. The 2G world with a single product (voice) has been replaced by a complex ecosystem, where operators need to redefine their role with multiple access technologies and multiple products and services. Today’s telecommunications is characterized by increasing complexity, cross industry collaboration, a coordination of networks of companies, an increasing convergence (of technologies, services and industries) and market saturation (with fragmentation of the service offerings). Parties in the market are mobile operators, hybrid operators, MVNOs, fixed and cable operators and new Internet comers (like Skype and Google).

Companies in the Business ecosystem (BE) have a common revenue/funding source (subscribers). BE work at many levels (firm, BU, products) and have impact on each other across different industries. One company can be part of several BEs, while one company can serve different BEs in different markets

Nokia characterizes a telecom BE based on complexity of the network (level of dependence on external ecosystems) and technical complexity (degree of ownership of technical and service platforms. A distinction is made between:

- river (low technical complexity /low network complexity) = network access provider
- raft (low technical complexity /high network complexity) = all types of virtual operators
- aquarium (high technical complexity /low network complexity) = operator owns everything, walled garden type of approach
- coral reef (high technical complexity /high network complexity) = Mobile Network Operators, but innovative, marketing oriented, technology neutral
Depending on the quadrant, operators role as an orchestrator of the telecom BE will vary accordingly. Within the BE the role of vendors (Nokia, Ericsson, Alcatel) is extending beyond simply providing boxes.

The regulatory authorities play an important role and can be seen as ‘Gods’ of the BE.

Nokia uses the telecom BE modeling to:
- Assess operational efficiency (mapping KPI’s to segments of the ecosystem)
- Analyze adoption of services by users (per segment)
- Build scenarios and analyze branding
- Brainstorm on operator differentiation strategies with the operators
- As part of Nokia marketing programs

Parallel Session A 2: Value Webs in Converging Markets

Presenter: Matthias Fischer (Vodafone Group R&D)

Matthias Fischer describes the main forces shaping the telecom industry which are a decline in prices, a lowering of entry barriers, saturation, a robust growth in broadband and triple/quadruple play. To generate organic growth several market players move forward to adjacent industries and try to bundle services. When the two different industries converge, it is not likely that the business will form a linear value chain with traditional vendor-buyer relationships. More likely, the business will evolve as a “value web”, a customer-centric market model of interdependent, specialized companies that contribute their capabilities to an overall value proposition, which requires the competitors to cooperate (“co-opetition”). A characteristic attribute of value webs is the hierarchical relationship between the shapers of the value-enabling platform and the adapters. Shapers define rules and norms for the interplay of participating players; the adapters’ task is to provide complementary products. However, this value web changes in time (value web lifecycle). It starts with establishment (1 platform, 1 shaper), then early growth (via leverage of external capabilities) and then turbulent growth and finally decline. A business model in the telecom market consists of a value commitment, a value web (with internal and external architectures) and revenue models. A trend is visible to modularize, products, services, processes and organizations.
Parallel Session A 3: Orchestrated Business Networks in the Mobile Services Industry

Presenter: Jarkko Vesa  
Reviewer: Javier Busquets

Jarkko Vesa describes governance models within the telecom world and compares the models used in Finland with those used in Japan. Finland uses a loose coupling mix & match model, decentralized networks with no single player in control (however, Nokia has a large influence). Japan uses tightly integrated operator driven (inter-market) Keiretsu like business networks. In the Japanese networked economy various industries are linked via one central coordinator (e.g. NTT Docomo) to build end-user services. A distinction can be made between top-down (technology centric approaches) and bottom-up (user centric approaches). A loose coupling of component designs allows mixing and matching for a large number of products variations. The question is to what extend can mobile services be modularized. The optimal coordination mechanism is highly dependent on the industry life cycle stage.

Some comments by the reviewer:

- how do (natural) resources and regulatory issues (like allocation of spectrum) impact your framework?
- Does your model take the open-software movement into account?
- There is an enormous cultural difference between Japan vs Finland. There is an important differing role of the government, this can drive a faster time-to-market. The Japanese culture drives certain types of SBN's to become more successful than in Europe. However, recent figures show that the markets in Germany and UK are (back) in front

Parallel Session A 4: Creating a Smart Business Network to Enable Online Hostel Reservations

Presenter: William Golden  
Reviewer: Steven Muylle

William Golden presents a case study Hostel world, where web services are used to open up a whole new sector (making bookings for hostels via the web), where other organizations perceived it impossible to make
money. Key points are simplicity (1 page A4 contract between Hostelworld and individual Hostels), plug and play compatibility (1 piece of script to connect to the webpage), a small fee per booking and salesmanship of the entrepreneur (who is a serial innovator). The strategy of Hostelworld is to own web-search, make use of affiliate programs and partner with Google. Currently, the model is extended to the mobile interface. Probably this company will be bought up within 5 years.

Some comments by the reviewer:
- what are the theoretical implications with regards to innovation, role of the entrepreneur, sustainability of the business model
- Are there opportunities for dynamic pricing and revenue management?
- How can the position in the hostel booking networks be further strengthened? What is the risk of a newcomer copying the concept?
- What is the impact of the venture capitalists as a catalyst for change?

**Parallel Session A 5: Business Agility: Need, Readiness and Implications for Smart Business Networks**

*Presenter:* Marcel van Oosterhout  
*Reviewer:* Amit Basu

Marcel van Oosterhout presents the results of two field studies on business agility needs, readiness and implications for the smart business network. The relation between IT (agility) and business agility is discussed. Finally, two case studies (energy and telecom) discuss the emergence of the smart business network. The presentation ends with a conceptual model to analyze the performance of the business network, which is defined by alignment (between business and IT), orchestration factors and Design factors.

Some comments by the reviewer:
- The paper actually consist of three sub-papers: what motivates industries in the need for agility, how do IT capabilities support or hinder agility and a framework for SBN performance.
There are technical, operational and cultural impediments in becoming more agile. Agility is an evolution of flexibility. Agility can be further structured as follows:

<table>
<thead>
<tr>
<th>Direction of the change in the business network</th>
<th>Scope of the change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>vertical</strong></td>
<td>e.g. change one supplier for another in existing logistics structure</td>
</tr>
<tr>
<td><strong>horizontal</strong></td>
<td>within existing structure</td>
</tr>
</tbody>
</table>

In the design of the SBN industrial characteristics and the environment should be taken into account.

How do you measure network business performance?

Try to analyze why (in the past) 85% of large scale IT projects fail. Everyone tries to re-invent the wheel, the same mistakes are made over and over (will this not be the case in SOA implementations??)
13. Semantically-enabled Service-oriented Architectures: An Enabler for Smart Business Networks

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Abstract

The term Smart Business Networks refers to two things: Firstly, an emerging concept for the agile composition of e-business value chains, and secondly a new stream of research, combining Management and Computer Science. While there exists a coherent vision of Smart Business Networks and the associated functionality, there is insufficient understanding of why creating and maintaining such infrastructure and networks is as difficult as being experienced in real-world scenarios. In this paper, we (1) trace back the complexity of issues such as partner selection, process composition, or execution monitoring to the lack of semantics in the description of system “elements”, (2) propose a semantically-enabled service-oriented architecture (SESA) as the foundational layer – or “Operating System” – for Smart Business Networks, and (3) show how our approach may significantly reduce the complexity of the core network management tasks by lifting them to a higher level of abstraction.

Keywords Service-oriented Architecture, Semantics, Layered architecture
Introduction

We are observing the move from e-commerce to e-business, to the Internet-based integration of business processes. This comes along with an “informatization” of entire value chains – in several industries – from the initial supplier to the final consumer. Electronic services become commodities, leading to selective outsourcing and, in consequence, to a further deconstruction of value chains. Outsourcing is based on the ad-hoc integration of services, blurring the borders of enterprises. As a consequence, the focus is not only on process reengineering, but increasingly on network engineering, with a quick connect and disconnect on a business level. These phenomena may eventually lead to Smart Business Networks (SBN) [1].

It is interesting to note the parallel emergence of two innovative but currently rather unconnected developments: Firstly, SBN research, having its roots in Management Science and Information Systems, and secondly Semantic Web Services frameworks, currently driven mainly by research communities in Computer Science. For an overview of the impact of semantics on Computer Science in general, see [2]. Following the SBN research manifesto and the related research questions, we concentrate on “What is the role and impact of new technologies on the creation and operation of value chains?”

In this organizational and technical context one can expect future systems with features supporting (see also [3])

- autonomous networked “nodes” with dynamic network configurations in heterogeneous and distributed environments,
- fixed and mobile communication – enabling access everywhere anytime,
- entire consumer life cycles and all business phases, across different businesses,
- users and businesses in selecting and (dynamically) bundling products,
- trust, scalability, and openness with respect to participants and services.

Given the above trends in e-business, the emerging concept of SBNs, the “required” features of such future systems, and the increasing application of Web Services, one may ask why the establishment of SBNs is still more burdensome, and not as agile as initially expected. Composing and managing value chains is still widely dependent on human labor for the discovery
of partners, the resolution of heterogeneity conflicts between systems, the monitoring of process performance and compliant partner behavior, etc. The amount of human involvement in the process lifecycle is in sharp contrast to the initial expectations of “on-the-fly” composition of new value chains, and it leads to high costs, conceptual inconsistencies, and the inability to exploit small or volatile business opportunities.

In this paper we argue that the major bottleneck is an insufficient conceptual model for the various layers that make up a value chain. In particular, the lack of formal semantics on the various layers prevents automated partner discovery, systems integration, and process monitoring, even for known patterns of problems; on top of that, the insufficient level of abstraction limits the reuse of existing process models in new contexts. We propose to use the layering described by the Semantic Web services community under the term “SESA” (semantically-enabled service-oriented architectures) as the conceptual foundation for SBNs. In section 2 we use a motivating example from the tourism domain for identifying requirements for a conceptual model, which we present in section 3. Section 4 shows how our approach can reduce the complexity of network management tasks. The final section gives a summary and highlights that SESA represents both a vision as well as a major challenge for Computer Science research.

**Application Scenario**

Tourism, which is one of the liveliest domains in e-commerce, may serve as an example of how SBN will be influenced by our approach ([3], [4]). Structurally, the tourism demand and supply side form a worldwide network, where both production and distribution are based on cooperation. Tourism is an industry where the diffusion of e-commerce led to the mentioned “informatization” of the entire value chain, in the sense that the flow of information determines the value chains. In addition, consumer behavior has changed regarding information needs, booking and travel patterns, which in combination have increased the importance of process agility for all market participants.

The following real world case may describe the needs for flexible cooperation between market participants, and a quick connect and disconnect: A middleman like a tour operator looks for 100 hotel rooms, with ski-lifts nearby in the region of Tyrol within 50 km. The aim is to bundle them with flights, in order to be able to offer a package with a max price of 450 €; dates are 05/07/06 – 15/07/06, service should be half board. And the package should have “interfaces” to flights from several cities, depending
on consumer requests. In this case the middleman may have contracts with some of the providers, but not all them. He starts communication sessions with some of them. In the course of his search, specific business rules are applied, e.g., that suppliers may require minimal occupancies or prices, whereas the middleman may have specific contract rules, or preferred partners, and he has his utility / business function. Obviously, this utility function depends on the type of middleman. In this case, networked business operations should allow for an n:m organization and communication between participating enterprises. This transfers the level from composing individual instances of services to composing sets of services; and from ad-hoc integration between two participants to an arbitrary number of cooperating enterprises. The orchestration of a large set of Web services – in the “automatic” bundling of products – requires possibilities for business planning with more refined means. Techniques of constraint reasoning, multi-value optimization and relaxation might be used to aggregate Web services at the set level and to achieve specific business goals, e.g., profit optimization or the equal distribution of income within a destination.

Such flexible network configurations, where processes go beyond company borders and thus lead to distributed “b2b2c” applications, will require cooperation between enterprises at an unprecedented level of complexity, specificity, and agility, and also the integration of interaction with the consumer based on mobile devices. Besides scalability and flexibility the following requirements can be identified:

- Support of autonomy and decentralization, with local “meanings” and business rules,
- Dynamism with the need for dynamic configuration and service discovery,
- Coordination and mappings of meanings,
- Robustness with a predefined quality of service,
- Modeling not only of functional, but also non-functional requirements,
- Security and privacy of information,
- Trust management,
- Access to legacy systems, enabling especially the participation of SMEs.

**SESA: A Layered Conceptual Model for SBNs**

In the domain of Web services, there is now a growing consensus on the fact that Services-oriented Architectures (SOA) have not yet delivered
their promise of “on-the-fly” services discovery, substitution, and composition because a semantic level, i.e., one that formalizes the meaning of services and their pre- and post-conditions as well as non-functional properties, was missing. As a consequence, Semantic Web Services frameworks, namely the Web Service Modeling Ontology (WSMO), OWL-S, and WSDL-S are gaining ground. We argue that the lack of a semantic layer is a similar bottleneck on the road to Smart Business Networks. Our vision implies the separation of business / process logics (expressed as a workflow or other form of process description) from the Web Services used (as well as the respective mappings), and where the created set of Web Services correspond to the implemented (business) solution. This is similar to the Open EDI Reference Model [5], with its separation of business and process logic from the implementation.

Figure 1 Open EDI Reference Model

The business operational view (BOV) addresses the semantics of electronic business – semantics of business collaborations and related business information exchanges – in a technology independent way. The functional service view (FSV) addresses technical and implementation aspects to support collaborations expressed in BOV related specifications. In such a way different FSV implementations for a specific BOV may be derived.

One should note that this approach also implies a transformation of meanings, from services as they are understood in management science to web services as defined in computer science. In management science a service is defined as a business economic activity (mostly intangible in nature), offered by one party to another to achieve a certain benefit ([6], [7]), and “generated” by (internal) business processes. In IS a service is a com-
plex (or simple) task executed (within) an organization on behalf of a customer ([8]).

And one should also note that service bundling – using a business term – differs from service composition ([9]): composition assumes a process description, whereas bundling do not make explicit assumptions about time order, but about service connectivity or it puts constraints on service configuration, e.g., bundle of services with overall minimum price. This highlights the non-functional aspects of service descriptions.

A Service-Oriented Architecture (SOA) is essentially a collection of services. These services communicate with each other. Such collections can be large - a service-oriented world will likely have millions or even billions of services. Computation will involve services searching for services based on functional and non-functional requirements and interoperating with those that they select. However, services will not be able to interact automatically and SOAs will not scale without significant mechanization of service discovery, negotiation, adaptation, composition, invocation, and monitoring as well as service interaction which will require further data, protocol, and process mediation. Hence, machine-processable semantics are critical for the next generation of computing - SOAs - to reach its full potential. The goal of Semantically Enabled Service-Oriented Architectures (SESA) is to place semantics at the core of computer science. In the following, we describe the layers of such architectures as

1. the problem-solving layer,
2. the common service layer, and
3. the resource layer,
and propose to use a similar layering for SBNs.

![Figure 3 Three Layers of Semantically-enabled Service-oriented Architecture (SESA).](image)

**Problem Solving Layer**

The objective of the **problem-solving layer** is to turn a service-oriented architecture into a domain specific business environment. Following the “layered” approach of our vision the problem solving layer represents the business operational view, covering both business model and business process models. In such a way it is the transparent interface to the business user(s), where we assume that all computing resources are turned into or expressed as services. The described flexibility (meeting the changing needs of a business / set of businesses) can be achieved by providing this clear separation between the business / process logic and the Web Services used. In order to provide solutions for distinct business problems – from an Information Systems point of view – the problem solving layer has to support the entire e-commerce framework – information, negotiation and settlement phases [10]. The objective is the efficient and effective “resource allocation” for an enterprise or a set of cooperating enterprises.

It has to support transactions, with different negotiation and contracting possibilities. In this sense it also implements a domain specific economic model, where services would be accompanied by specific functional and non-functional “parameters”. The architecture should support the implementation and operation of so-called smart business networks, on the level
of flexible e-business cooperation.

The approach should support the modeling and implementation of a (collaborative) business model. In addition, since no network of businesses operates in an open environment, the vision needs to enable trust domains in which all services are defined in terms of their trust levels and capabilities. This must be based not only on functional requirements but also on non-functional requirements covering business and trust aspects (covering issues such as price of a service, type of payment, performance, reliability; or also security levels, authorization, and past history).

**Common Service Layer**

As computer science moves to the next period of abstraction, the practice of developing software applications evolves to the modeling of semantically annotated services that can be composed, i.e., can co-operate, to achieve specific tasks. This leads to a flexible, decoupled world of independent services that can be dynamically discovered, combined, and invoked. The common services layer (CSL) provides an adaptive execution environment and supporting infrastructure that maps the problem descriptions generated at the Problem Solving Layer to the services that can solve the problems.

The Execution Environment at the heart of the CSL requires components to map problem descriptions at the problem-solving layer to available services at the CSL. Existing architectures (e.g. Open Grid Service Architecture (OGSA) in the Grid area) already support such mappings for components and prototypical interactions, however they operate over purely syntactic descriptions, hence domain specific problem solutions must be coded manually. Besides providing the interpretation of semantic description the CSL needs also to be able to execute descriptions and therefore needs to interoperate with standards defined at this lower level. The Web Service Description Language (WSDL) is used to syntactically define the interface of a component using standard web technologies to define means to invoke operations but it does not define notification mechanisms or a standard way of interacting with stateful resources. The Web Service Resource Framework (WSRF) is a standard that extends WSDL in this direction. Initiatives that define syntactic descriptions of resource are orthogonal to the semantically empowered common service layer. The CSL will make use of the former to facilitate the execution of service requests.

The core of our approach is the semantic enrichment of SOAs that implement the Common Service Layer capabilities. This enrichment helps to automate (1) service discovery, service adaptation, negotiation, service composition, service invocation, and service monitoring; as well as (2)
data, protocol, and process mediation. This automation is a prerequisite for SOA scalability. To achieve this, we are developing the W<Triple> technology that combines the following major building blocks.

- The **Web Service Modeling Ontology (WSMO)**: a conceptual model for structuring semantic annotation of services [11],
- The **Web Service Modeling Language (WSML)**: a family of languages providing formal semantics for WSMO models [12],
- The **Web Service Execution Environment (WSMX)**: an execution environment for the dynamic discovery, selection, mediation, invocation and inter-operation of the semantically described Services [13],
- The Web Service Composition Component (WSCC): an component for the automatic composition and optimization of aggregated Web Services [14], and
- Triple Space: [15] and [16]: a protocol for the communication of services based on persistent publication of information following the web paradigm.

**Resource Layer**

Resources are used to solve problems or more conventionally to execute applications. The resource layer [17] deals with resource discovery, selection and negotiation for advanced or “on-the-fly” consumption of resources. The resource layer also covers the deployment and provisioning of physical and logical resources. Resources in the context of an SOA can be subdivided into multiple classes covering, among others, both physical and logical resources. Physical resources (e.g. computers, data servers, and networks), which are commonly connected to form a grid of computing and storage platforms; at this level automatic resource management will be facilitated from the perspective of both resource provisioning as well as its lifecycle management. Logical resources, such as application components or common services, enabling more advanced composition of applications.

Two of the most prominent and widely discussed areas that deal with distributed resources in the context of Service-Oriented Computing are Ubiquitous Computing and Grid Computing. They can be seen as two endpoints in a continuum where their characteristics are somewhat complementary. Grids rely on a relatively large number of hardware devices ranging from small computers to very powerful devices interconnected with mostly conventional networks (Internet). Ubiquitous Computing environments, on the other hand, are suffering from weak and unreliable connections (due to partial autonomy) in very dynamic constellations of a high
number of mobile devices with limited memory and processing power.

We assume that using the three layers presented as the conceptual model for SBNs and representing aspects of actual SBN elements using formal semantics (e.g., in WSML) will dramatically increase the degree of automation in the lifecycle of value chains. This is in particular a library of problem solving methods, i.e., the problem solving layer, which can be automatically matched against actual tasks in the SBN environment. For instance, known conflicts between two data representations or process choreographies can be bridged using a reusable mediation component for this particular task. Also, even if resolving all conflicts in a given scenario cannot be fully automated, it will be still beneficial to deduce conflicts by machine reasoning.

Preliminary Evaluation of SESA-based Smart Business Networks

In this section, we show how our approach – using all three layers – could reduce the complexity of the aforementioned core network management tasks by lifting them to a higher level of abstraction.

Technical Integration

The SESA idea includes, as a core design element, mediation [18]. Mediation means computational functionality that can bridge heterogeneities between systems, e.g. data representation mismatches or process incompatibilities. The layered approach of SESA allows for establishing a library of mediation components for various purposes, thus lowering the amount of proprietary software engineering in systems integration. Since the capabilities of mediators in a SESA framework are again described using machine-processable semantics, the discovery of needed mediation components can also be supported by machine reasoning.

Partner Selection

Partner selection, often also referred to as “Matchmaking” (cf. e.g., [19]) or “Discovery” with blurring borders between these terms, involves all tasks of finding, ranking, and selecting suitable business partners for a given task. This process is extremely complex in real-world business scenarios, for several reasons (as shown in section 2). Firstly, most available resources are not described using a common conceptual framework, and in particular not described using a single ontology. This makes it hard to impossible to include all suitable matches; in other words, precision and re-
call remain unsatisfying due to the inability to include implicit knowledge about available resources. A typical example is that “This service provides data mediation between X12 and proprietary formats” may mean at least two different things: It can mean that the service can mediate between any X12 variant to any from a finite, consensual set of formats. It may also mean that the service can only mediate between some of them. Also, resource description on such low levels of expressivity often completely ignores actual availability of resources. However, it is a triviality that e.g. the actual pricing will be substantially affected by the amount of available resources.

Secondly, the utility (in the economical sense) of a resource is usually affected by multiple characteristics of a service, and there is a multidimensional trade-off between various properties. Thus, the strict separation of discovery into coarse search (“discovery”) and negotiation is flawed in many practical scenarios. The description of resources at a semantic level using ontology languages allows the use of machine reasoning and the use of implicit information in the process of partner selection. The description of services on the Common Service Layer and the Problem Solving Layer allows the reuse of existing functionality in the process of partner selection and will thus expand the search space.

**Contracting**

The actual contracting about a service is currently subject to the prior establishment of a framework contract. E.g., a travel service provider may enter into an agreement with either a network of travel resource providers or individual providers, and may then trigger contracting on an instance basis automatically. This works well as long as the amount of transactions per framework contract is high. However, as soon as the number of potential partners increases and the number of transactions per each business partner decreases, the overhead caused by establishing framework contracts prior to contracting individual business transactions may become prohibitively high. The representation of pre-conditions in a SESA architecture and business policies using rule languages will allow for making the contractual dimension accessible to machine reasoning. Even if framework contracts did not become obsolete, their establishment would consume less resources and cause less delay. In a SESA environment, legal ontologies could also be imported that allow matching the bilateral agreements to the general legal environment.
Process Composition

At a business level, process composition is often regarded as the mere ordering of activities by causal or temporal dependencies. However, at a higher level of abstraction, it becomes obvious that process compositions created this way may be inconsistent, since they may violate constraints in the form of pre- or post-conditions. The SESA approach includes expressive formalisms for encoding the pre- and post-conditions of any service. This allows for validating such complex processes that were composed manually, and it will also support the development of tools for the semi-automatic composition of processes. Note that the SESA idea separates the representation from the automation of a task in the lifecycle. Even if fully automated process composition is computationally too expensive, SESA still allows capturing all relevant aspects of the system. In other words, the SESA conceptual model is guided by the idea of providing a comprehensive capture of all relevant aspects, not by the question whether the respective representation can be used in a fully automated manner.

Conclusion

In this paper we argue that current SBNs – falling short in terms of the agility of value chain composition since they lack a comprehensive conceptual framework – may benefit from our approach. We trace back the complexity of partner selection, process composition, and execution monitoring to the lack of semantics in the description of system elements in SBN environments. We show how our approach may reduce the complexity of the aforementioned core network management tasks by lifting them to a higher level of abstraction. As a consequence, we propose to adopt the layered conceptual model of semantically-enabled service-oriented architectures (SESA) as the foundational layer for Smart Business Networks.

But the proposed SESA framework also represents a vision and a challenge in Computer Science, which itself is on the edge towards an important new period of abstraction. A generation ago computer science learned to abstract from hardware and currently learns to abstract from software in terms of service-oriented architectures (SOA). SESA brings now machine processable semantics to SOAs in order to leverage its full potential. In the long term, the objective is to provide a new operating system – supporting SBNs – that provides a smooth and transparent integration of millions of resources and services on a worldwide scale.
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Abstract

Establishing industrial service-oriented business operations is a challenging process. Rapidly changing business environments and intertwined dynamics in business model, organizational operations and technological enablers make it difficult to capture the requirements for an ICT system. In this paper, we present a case study of two organizations in the paper industry aiming at developing mutual service-oriented business relationship. The paper analyzes the steps involved in the transformation from product-oriented business to service-oriented business, presenting major challenges and some solutions for solving these.

Keywords Business networks, service-oriented business, ICT, challenges, organizational transformation

Introduction

Industrial service business and service-oriented products are defined as activities taking place through interaction between the customer and the service provider, their physical resources and/or their information systems, and that are offered as solutions to the customer’s problem [13]. A service
has several characteristics: they are processes composed of activities or of sets of activities (and not physical products), they are produced and consumed simultaneously (at least to some extent), and the customer participates to the production of the service (at least to some extent). According to Edvardsson and Olsson [10], a service is distinguished (from a product) by participation; the customer contributes the process, and have influence on the outcomes, quality and value of the service.

Currently there is a trend in traditional industrial companies to move towards more service-oriented business operations [36]. This implies developing new business operations by offering support services such as maintenance and repairing services, analysis of problems or potential problems, and fine-tuning and modifications for improved performance of the machine.

The major forces driving this transition are the technological advancements in the machinery, and the advancement of ICT technology enabling previously unknown business models. The life-cycle of the machinery has prolonged significantly during the past decade, and at the same time the machines have become more complex. Therefore maintaining, repairing and upgrading them require special skills which most production plants cannot afford to keep in-house. Paper mills, for example, are experts in making paper and selling it – not in maintaining, repairing and upgrading the paper machine itself particularly in situations when a problem to be fixed is not simple and self-evident. Consequently the machine suppliers have been able to increase their after-market sales volume by starting to offer different kinds of services.

Examples of different fields of industry that have successfully adapted service-oriented business operations include shipping [4], aircrafts [34], and pharmaceutical industry [31]. In the offshore industry, the “second generation” (G2) of integrated work processes is defined as processes that will help operators utilize vendors’ core competencies and services more efficiently through digital services, such as real-time data analysis and remote operation and maintenance of drilling equipment [24]. However, although the enabling ICT technologies now are available, the diffusion of service-oriented business in industry is still rather slow [3]. Several challenges for the realization of industrial service business have been identified related to different aspects of this concept, such as the lack of a joint, mutually agreed, explicit business model [15], incompatibilities in both IT infrastructure and its process support [17], and problems in supply-network management [28] or in controlling the business networks [33; 35]. As exemplified by the oil industry, the implementation of G2 processes is required to be demanding, “as the roles and responsibilities of operators and vendors have to be redefined, contracts and incentives that facilitate pro-
curement of digital services must be established, and new competencies, services, technologies and common data standards developed” [24].

Defining the nature and scope of new services that could be provided to customers and partners can be perceived as challenging both from the customer and service provider. This represents a shift from traditional work models into new business process designs with little experiential support to build upon. This will be illustrated in this paper through our experiences from a research project conducted in the Finnish paper industry. Here, neither the service producer (i.e. the paper mill manufacturer) nor its customer (i.e. the paper mill), had an image of what the service would be or how it could be used. Particularly, this applied to the paper mill although it was not clear or well-defined at the paper machine manufacturer’s side either. Thus, using the aforementioned definition of a service, this process is not well-defined and it is not consumed (i.e. the outcomes of the service are not exploited), even if it is produced in a participatory manner (by the paper machine manufacturer observing the customer through remote diagnostic tools). In this project we studied two organizations, a service producer and their customer, and tried to construct ICT support for industrial service business. The aim was to synchronize the factory-floor level operations so that services can be offered and consumed effectively.

The paper intends to make a contribution in several ways. First, we present a case study that illustrates challenges in transforming traditional product-oriented business to service-oriented business. Second, we discuss different solutions to solve these challenges and problems, and present a framework that can be used in gathering information and analyzing it in weakly defined situations. Finally, we bring together these challenges and solutions in the form a step-wise approach for establishing a service-oriented business operation.

Related research

Research on the use of IT for supporting inter-organizational collaboration between partners in the supply chain dates back four decades. Already in 1966, Kaufmann discussed how the development in computer and communications technologies would lead to systems crossing organizational boundaries [20]. Interorganizational information systems (IOS) have been defined as “an automated information system shared by two or more companies” [6]. Several studies have addressed the challenges involved in implementing IOS (e.g. [7; 12; 22; 37]). Examples of critical success factors for IOS identified in this research include shared vision, cross-organizational implementation team, executive level sponsorship within
each partner, high integration with internal information systems, interorganizational business process re-engineering, advanced legacy information system and infrastructure, and shared industry standards.

While the IOS projects initially was mainly restricted to automated business transactions, e.g. based on Electronic Data Interchange (EDI), the availability of web-based services has expanded the focus of interorganizational collaboration to also involve interpersonal collaboration in the form of interorganizational teams for product design, development and maintenance [37]. It has been argued that collaborative commerce (c-Commerce) would represented the next stage in the development in e-Business applications, expanding beyond mere transaction processing to also include dynamic collaboration among employees, business partners and customers [4]. Although this term has been subject to some hype in the industry press [1; 21], several have pointed to that the concept has yet to be clearly defined and that level of integration and collaboration implied in this may be hard to realize in practice [11]. Key barriers are recognized as being more human than technical, i.e. related to distrust, departmental boundaries, and disagreement on internal and external collaboration. A distinguishing characteristic of the companies that have reached the highest level of intercompany integration was the development of a blueprint or architecture that lays out a business and technology design that works across companies [16].

A term closey related to service-oriented business operations is that of co-production, defined as the direct involvement of customers in the design, delivery and marketing of goods and services that they themselves consume [32]. This implies collaboration (or co-laboring) between customers and service providers, and is characterized by the following three dimensions:

- **Activity**: design (requesting assistance), delivery (participating in development), marketing (recommending and referring)
- **Mode of cooperation**: customer motivation (voluntary & compliant), customer participation (active and passive)
- **Type of interdependence**: sequential (planned coordination), pooled (standardized coordination) reciprocal (mutual adjustment).

In addition, Schultze and Bhappu (op.cit.) apply the design contingences of *input uncertainty* and *performance ambiguity* as the basis for specifying the most effective forms of co-production in different service environments. Input uncertainty is here expressed in terms of the amount and equivocality of information needed from the customer, while performance ambiguity refers to the difficulty of assessing service or product quality.
Several frameworks for e-service requirements analysis and design have been suggested, that are relevant for the development of service-oriented business operations. For example, Orriens and Yang [25] argue that business collaboration design needs to apply software development principles, and incorporate support for specification of relationships among requirements and capabilities of different participants. They present a Business Collaboration Design Framework (BCDF) for designing business collaboration, consisting of three types of generic meta models (business, conceptual, and logical) that provide design guidelines, and models which represent a particular design of an application. The framework is specifically intended to support compatibility management among business collaboration participants, thus extending this type of support compared to other process modelling frameworks such as the Business Process Execution Language (ibid.). The BCDF framework views business collaboration design from three different perspectives: collaboration, describing behavior between participants in business collaboration; participant, describing the behavior of individual participants; and local, describing private behavior which is only of interest of a particular participant [26].

Colombo et al. [8] define a methodological approach for the design of e-services that supports the specification of inter-organizational coordination and control requirements. This methodology comprises three phases: 1) Goal-oriented specification of cooperation requirements includes the specification of market players and dependencies, and refinement of coordination and control goals, tasks and resources; 2) Conceptual specification of cooperation requirements with UML operationalizes goals, tasks and resources, specifies exceptions and compensation actions, and sequence diagrams; and finally 3) Implementation, where the transactions are mapped into a set of e-services and the e-service descriptions invocation schema (translation of the ordered sequence diagram formalized in step 2) are implemented.

This brief literature review shows that relevant research can be identified under different headings, such as IOS, e-commerce, co-production, and e-service analysis and design. However, while this research addresses various challenges related to establishing service-oriented business operations, there is a lack of a holistic process model for simplifying this process. Further, most of the identified frameworks and methodologies focus strictly on the role of ICT for supporting activities that can be modeled within the system. Our experience, though, is that most of the coordination and work activities actually take place between people, thus making ICT-oriented frameworks incomplete. We return to this discussion later, after first presenting our case experiences.
Case study

For the last two years we have worked with a paper machine manufacturer and a paper mill trying to develop ICT solutions to support activities at the floor levels of the mill and at the manufacturer’s site. In other words, we have tried to synchronize the workflows and to support cooperation between groups of experts in two organizations with different objectives, strategies, cultures, operations, practices, and technologies. Over this period we have conducted numerous interviews and workshops to understand the problems and challenges of a new business model and their implications to ICT solutions. In the following we briefly describe the different activities involved in this project.

3.1 The change in the business environment

We begin with presenting the problem setting, the starting point of our research project, to illustrate the driving forces behind the transformation of the business models. Figure 1 depicts the transition of the machine supplier’s business model from a producer of products to a producer of services. Technologies, particularly ICT technology (e.g. network connections, remote monitoring), enable new business models and organizational modes. However, the technology cannot be fully profited unless the business model and organization and its operations are also changed. For instance, for a videoconferencing system to be useful, at least a portion of the meetings must be held through it to cut travel costs thus forcing a change in organizational operations. Similar, the change in the business model (inventing a new business concept) or organizational operations (changing work processes) have their impact on technology and organization/business model (c.f. [23]). The initial points of transformations are thus more or less intertwined. Similarly, in our case, technological advancement enabled new business models and organizational operations for both the machine supplier and its customer. This forced us to study the business model, operations and technologies in parallel, where none was fixed.
Our case study was performed in a network of two organizations: service provider (a paper machine manufacturer) and their customer (a paper mill). A paper mill is a complex construction where more than 10-meters-wide stream of paper runs through the machine as long as 160 meters at almost 2000 meters per minute. Paper is rolled into rolls size of up to 10 meters wide and 6 meters high. Robinson et al. [30] described paper mills (and the machines) to be “fundamentally a set of interlinked machines using bearings, rods, connectors, pumps, gaskets, cylinders, drive belts, and so forth, that make up most mechanical devices of this size […]” (p. 65). What is important here is that much of the machine is controlled, monitored, calibrated, and adjusted by a multitude of electronic devices and computers. Thus, a paper machine (depending on age and design) may incorporate thousands of logic and process controls each having their own computer. Also, although the paper machines look the same, each one is unique. Depending on the paper grade, they are configured differently, use different kind of pulp, and have their own history of “updates”, i.e. newer computers or sensors. This complexity sets requirements for the staff at the paper mill – they have to be able to handle a myriad of different automation systems and computers, and to be able to combine that information when fixing problems. In their current economical situation with global overproduction of paper, the paper mills cannot afford to keep such expertise in-house and prefer to buy it as services.

Paper machine manufacturers are also struggling with a changing business environment. Because of the overproduction, new paper machines are no longer bought in masses. Instead, paper mills invest only in small upgrades. However, because of a need for advanced services related to paper machines, paper machine manufacturers are starting to offer these. Such services include maintenance and repairing services, analysis of problems
or potential problems, and fine-tuning and modifications for improved performance of the machine. There is a mutual understanding about the vital need for industrial services both at the paper machine manufacturer and at the paper mill. However, although the technologies enabling the service business are available, the companies still do not know the business model, organization or organizational operations, or the transformation from their current modes to new one, that are required to develop successful operations.

We, the researchers, were hired to study and develop ICT-based solutions to support the cooperation between the two organizations. The focus was particularly on synchronizing the factory-floor level operations, so that maintenance and problem-solving services could be provided and utilized at the mill.

### 3.2 Modeling the operations

The project begun with usual modeling of the business environment and the creation of the use cases to gain mutual understanding of the problem and the concept. However, it soon turned out that the use cases could not be created. This was due to the “fuzzyness” of the future business process. The participants in both organizations could not provide information for the use cases simply because they did not know what the processes were, neither at this moment nor in the future – they were not able to articulate them. This articulation problem becomes especially significant with the nature of the service business: a service is distinguished from a product by participation. Rhetorically, if participants cannot identify or articulate their own roles in a joint process, how can they cooperate and interact, i.e. to have an influence on the quality and values of the outcome, as expected in service business? In our case, as this interaction was both between information systems, and between people, it resembles the development of a CSCW (computer-supported cooperative work) system.

Osguthorpe et al. [27] have proposed a method for developing CSCW systems. The method is based on three modeling perspectives: process, information and organizational structure, but is lacking a technology component. Also, the method is quite technically-oriented aiming at technological improvement, not business process or organizational operation improvement. Still, it is a rare example of a method that reveals appropriate information (c.f. [19]), thus we adapted it as a basis for developing a new method to elicit the requirements for weakly known business-processes.
The requirements elicitation was based on the process modeling [9]. It was believed that by modeling present service processes between the organizations, bottlenecks and the points of failures could be identified and overcome. Also, while doing this, the background information about the process, participants in both (all) organizations, information flows and the technologies in use was gathered. This information could be further used in developing the systems.

Figure 2 illustrates a part of a contract-based monitoring process. There, the workflow, participants, documents and other types of information, and technologies are shown. In this process, the modeling revealed the lack of communication and non-existence of a workflow both at the customer side (although they claimed it existed), and between the customer and the service provider. Thus, it gave a starting point to dig into the details of activities inside and between the organizations. Similar kind of process models were created from a number of cases varying from monthly operations (as in Figure 2) to unique problem-solving situations.
3.3 Analyzing the models and their creation

Analyzing the process models showed the information needed for ICT development. However, it also exposed other issues that could not be solved only by technological improvement. For example, the reasons for the aforementioned gap in the information flow between the service provider (manufacturer) and the customer (paper mill) turned out to be the lack of understanding the benefits of the service at the factory-floor level. The person receiving the maintenance report containing suggestions for changing some parts of the machine did not make use of it. Instead, it was filed (and forgotten). In other words, although the customer had signed a contract agreement, it was signed at such a high level of the organization that people participating in the actual process did not perceive it as beneficial. Organizational operations did not follow the advancement of technologies and the business model.

Correspondingly, the models revealed the ad-hoc nature of business model at the service provider side. Although their operations and ICT systems supported service business up to some extent, the process was vaguely defined thus making it difficult to evaluate its cost-efficiency, and more importantly, to present it to the customer to justify the cost of the service.

ICT infrastructure existed and was in use in both organizations. However, there were (and still are) several problems when it was attempted to be used in service business. For example, in the mill different technologies were designed to execute or support some particular task of the machine. Information from different sources was never gathered or automatically analyzed but was presented on various unconnected displays, observed by the mill operators. Comprehensive ICT infrastructure did not exist [2]. Likewise, the service provider utilizes internal information systems, but the interface between them and the mill side systems is incomprehensive – only a portion of information available is transmitted. This becomes particularly problematic when analyzing whether the suggestions for improvements or for problem-solving have been considered. The service provider has no means to monitor whether the improved situation was a result of their suggestion or whether it was caused by some other maintenance maneuver. This gap is caused by both the incomplete ICT infrastructure and lack of contextual information from the mill. Or, in other words, although the business model is (theoretically) appropriate, technologies and organizational operations are not meeting the related needs.

Our work in the case has provided twofold results. First, we have modelled the processes both locally in each organization and between them, and from those models, identified difficulties in establishing the business

processes. Second, we have constructed a simple “portal” that conveys information between the organizations and allows both sides to be aware of activities of the other (increasing transparency). Although the tests and trials of the portal are still ongoing in organizations, initial results indicate we are on a right track. However, more detailed analysis of the use of the portal and its implications need to be done.

**A process view on establishing service-oriented business**

The case study presented in the previous section illustrated several challenges in the process of establishing service-oriented business operations. Taking on a holistic perspective, Table 1 provides an overview of the steps and related challenges as identified in this process.

<table>
<thead>
<tr>
<th>Step</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Service-concept definition and requirements analysis</td>
<td>Unclearness of the service concept and business model</td>
</tr>
<tr>
<td></td>
<td>Difficulties in articulating current processes and roles</td>
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<tr>
<td></td>
<td>Lack of mutually agreed service process</td>
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<td></td>
<td>Lack of transparency in the service process</td>
</tr>
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<td></td>
<td>Requirements elicitation in general</td>
</tr>
<tr>
<td>2. Development of ICT infrastructure and appropriate services</td>
<td>Fragmented ICT infrastructure</td>
</tr>
<tr>
<td></td>
<td>Infrastructure as a whole not supporting networked operations, and not designed for service-business</td>
</tr>
<tr>
<td></td>
<td>Lack of contextual information in offering services</td>
</tr>
<tr>
<td>3. Implementation and change management</td>
<td>Changing individual work practices</td>
</tr>
<tr>
<td></td>
<td>Organizational culture not supporting new practices</td>
</tr>
<tr>
<td>4. Benefit evaluation</td>
<td>Defining measures and methods for identifying tangible and intangible benefits from the implementation of service-oriented operations.</td>
</tr>
</tbody>
</table>

In the following we briefly discuss each of these steps, based on experiences from our project and with reference to related literature.

**Service-concept definition and requirements analysis**

Colombo et al. [8] explicated the requirements for inter-organizational control and coordination, discussing e-services development from a technological (electronic) perspective. The phases of this methodology make
an implicit assumption that all the activities take place in an electronic form, inside the system. Consequently, there is no need for coordination outside the EDI system. In our case, although the services were (partly) enabled by ICT, actual service operations (i.e. actions according to the electronic suggestions) were performed elsewhere (e.g. on a physical machine) that cannot be completely monitored from the distance. The concept of coordination is thus not only about coordinating electronic transactions, but also actions that take place outside the ICT infrastructure. Hence, in this case and we believe that also more generally, the technology is rather an enabler than the tool to transmit everything, including the service.

Schultze and Bhappu [32] characterized service-oriented business as activity (design, delivery and marketing), mode of cooperation (customer motivation and participation) and a type of interdependence. In our case, the importance of the dimensions of the mode of cooperation and the type of interdependence is emphasized at the expense of activity dimension. This is because the activity is something that can theoretically be supported by ICT if the other two are rigid. Business model (type of interdependence) and organizational operations (mode of cooperation) were not fixed thus their proper support could not be designed either.

Gossain [11] argued that the concept of c-Commerce has not been clearly defined. He recognized key barriers for c-Commerce that are also applicable in industrial service business context. Departmental boundaries, disagreements in collaboration among others were all identified in our case. That is not novel. However, we believe that they are due to the changing nature of business environment and intertwined nature of business model, organizational operations and technologies and of their transformation. Consequently, our findings can be seen to concretize the c-Commerce concept.

Heikkilä et al. [14; 15] discussed some of the solutions to interorganizational implementation (e.g. articulation of objectives, defining, introducing and implementing new work practices). However, they assume the rigidity of operations and activities, which were not defined or possible to articulate in our case (input uncertainty as defined in [32]). A new method considering the dynamical nature of operations and business environment is needed. For example, the process model briefly presented in this paper is one of the possibilities to capture multiplicities of organizational activities.

**Development of ICT infrastructure and appropriate services**

While it could be argued that the key challenges in developing services-oriented business are related more to the organizational than technological
aspects, ICT infrastructure still represents a key challenge. As illustrated in our project in the paper industry, this infrastructure currently is often very fragmented, with systems operating more or less independently from each other. However, for successful service business, awareness, adaptability and learning capabilities need to be supported [36] to achieve contextual information. This sets a requirement for an ICT infrastructure. One cannot start from a whiteboard but has to rely on current environment, and develop e.g. a portal through which the awareness and contextual information can be gained. Further services can be implemented in the portal so that the users can be fully aware of the activities of the other, thus increasing transparency between the organizations. For example an interface to both organizations’ ERP systems can be designed.

**Implementation and change management**

Despite the problems and challenges identified, the organizations in our case are keen on moving towards service-oriented business operations. Yet, although there are some technologies to support new operations, and new systems are coming, we believe more challenging is their organizational implementation. Replacing old work practices and processes with new ones is always challenging, nevertheless it is even more difficult if the organizational cultures do not support such operations even in fundamental level, not to mention technological. In our case, the implementation of these technologies implicates changes in the paper mill’s daily operations, and may even cause their personnel to become expendable. Atmosphere at the mill does not courage the change.

**Benefit evaluation**

IS benefit evaluation is difficult even in single organization case. According to Hu and Huang [18], IT investment evaluation should be performed against the firm’s strategy. Often this evaluation can be done beforehand estimating different tangible and intangible benefits. However, because of the novelty of service-business and involvement of two organizations, the evaluation of the benefits an ICT solution is very difficult. For example, measures and metrics are dependable not only on the performance of an organization but require contributions from both parties.
Conclusion and implications

In this paper we have presented a list of steps in the process of establishing service-oriented business operations, supporting the transition to integrated work processes between industry partners. This integration is emphasized because of the nature of the service business: it requires participation from both service provider and customer. We argue that this list expands former research, that tends to provide a somewhat simplified view to the business environment [e.g. 8; 14], lacking a dynamic, holistic view of intertwined operations of business model, organizational operations and technological enablers. The framework presented in this paper better encapsulates a new, mode adaptive method to cope with such an extensive change in the business environment. Biehl et al. [3] asked why service-oriented business operations have not got more popular even the technologies are available. As our case illustrates, the situation is not simple and limited to technological implementation only. Equally important are other levels of the framework.

As our project is still missing thorough evaluations of the technology in use, and it is just a case, more research is needed. However, we believe these findings both help practitioners in developing different service-oriented business operations and systems (that they do not do the same mistakes) and provide a basis for researchers trying to understand the phenomenon. Each step identified in establishing the business operations needs more research as all the challenges and potential solutions are not identified. Service-oriented business operations are very complex.

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References


15. Smart Business Networks Design and Business Genetics with a High Tech Industry Case

By L-F Pau

Abstract

Despite the emergence of smart business networks, agile networks, etc. as important research areas in management, for all the attractiveness of these concepts, two major challenges remain around their design and the partner selection rules. While smart business networks should provide advantages due to the quick connect of business partners for selected functions in a process common to several parties, literature does not provide constructive methods whereby the selection of temporary partners and functions can be done. Most discussions only rely solely on human judgment. This paper introduces both computational geometry, and genetic programming, as systematic methods whereby to display possible partnerships, and also whereby to plan for their effect on the organizations or functions for those involved. The two techniques are also been put in the context of emergence theory. Business maps address the first challenge with the use of Voronoï diagrams. Cellular automata, with genetic algorithms mimicking living bodies, address the second challenge.

To illustrate the approach, some experimental results from the finance function in a high tech industry, are discussed; they address the case of how to determine the adequateness of a systems integrator to set up joint ventures with smaller technology suppliers.

Keywords: Smart business networks, Design of smart business network, Genetics, Cellular automata, Emergence theory, Computational geometry, Voronoï, Smart business maps, Business genetics, Technology management, High technology industry alliances
Plan

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1. Critical review of smart business notions
2. Smart business networks and emergence theory
3. Smart business maps
4. Voronoï diagrams and coordination
5. The smart business network dynamics
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7. A Case from the high tech field
8. Conclusions
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0. Introduction

The management concepts around “smart business networks” have appeal to general management as a structuring notion, and to information management as a means to highlight how communications and information can structure organizations and not just processes. However, these concepts and related management research fail to offer the needed methodologies and tools whereby the underlying forces (creative, disruptive, or regenerative) can be identified; they do not either give means to elicit, in view of discovery of partners, the business and organizational rules whereby such smart business networks actually can exhibit any smartness (as defined and discussed in (Vervest, Heck, Preiss, Pau(2005)). The difficulty lies in large parts in the fact that general management, information management, and business process management being in the philosophical sense “reductionist” approaches with a tendency towards static mechanisms, they cannot tackle the complexity and volatile behaviours encountered in what are considered as being real live cases of smart business networks. The notion of "business operating system" is one such example of a very limited reductionist if not even normative view of such networks.

This paper goes well outside avenues normally considered in general management and information management, by taking inspiration from emergence theory in philosophy on one hand, from genetics, cellular automata and computational geometry on the other hand, to identify methodologies and tools helpful in eliciting the business and organizational
rules whereby smart business networks can eventually exhibit common forms of smartness.

Also, the paper is discussing an implementation case, by reviewing the proposed approach for evaluation purposes. While details cannot be given due to their very real and time critical nature, this part of the paper shows how a large systems integrator in the high tech field can decide to initiate and terminate technology agreements (or technology joint venture agreements) with smaller technology suppliers.

By addressing such issues in this way, this paper points at business genetics as an interdisciplinary research area with direct business implications, from technology management, to mergers and acquisitions, to business process strategy. By business genetics is here meant the application and adaptation of genetic processes from biology and cellular automata, to business relations and organizations.

1. Critical Review of Smart Business Network Notions

The initial concepts in smart business networks were presented in (Vervest, Heck, Preiss, Pau (2004); Vervest, Heck, Preiss, Pau (2005)) with as core notions:

1. Agility (Pal et al, 2005),
2. No definite lasting commitments (uni-or multilateral),
3. Process specific, and
4. The use of communication and signalling networks as command / synchronization lines (Pau, Vervest (2005)).

A smart business network does not have to rely on mutual equivalence structures (Weick (1979)) defined as implicit contracts between people that can be built and sustained without knowing the motives of another, and without sharing goals. A smart business network may have to use network management rules, or so-called “business operating systems”, provided they preserve all the evolutionary aspects ((Pau (2005), (Klein et al (2005), (Bahrami (2005)), but may also develop without such rules up to a certain level of complexity to avoid the reductionist implications of such rules.

Smart business networks are not informal networks as found in most social groups and even some industry sectors. Although they retain the innovative dimension of informal networks (Ehin (2005)) they have de-
Smart business networks are also a departure from knowledge sharing concepts (or networks of practices) where parties have to agree on goals and behave consistently; the difference resides in the explicit organizational existence and recognition of different interests, preferences, and goals across the smart business network. In order to achieve some of these ends, initiating parties have to initiate actions towards others by which they create mutual commitment and interlocked behaviours, to collectively pursue diverse ends through selected common means. Once people are engaged in selected mutual commitments, a subtle shift takes place from diverse to common ends. Diverse ends remain but they become subordinated to an emerging set of shared ends. We characterize this evolution by the dynamics of the ratio of shared goals to total goal set cardinality, for each party; if \( N(i) = \text{Card}(\text{Goals}(i)) \) is the cardinality of all goals of party \( i \), the ratio is initially \( 1/N(i) \) for one \( \text{Card}(i)=1 \) party, to reach a value \( q \), larger or equal to \( 1/N(i) \), in a smart business network involving \( \text{Card}(i) = p \) parties; much of the dynamics in the smart business network can be seen from the time-dependent evolution graph of the pair \( (p,q) \) called smart business network consistence graph. This graph is comparable with the genetic signature fit between living cells in biology and genetic engineering.

Smart business networks are a departure as well from business process management systems (Chang (2005)) as BPMS standards and service oriented architectures (SOA) rely on identifying the full set of capabilities, data integration, messaging based integration, and software component based integration steps needed to execute a specified process. Business process management relies on decomposition of the process and task allocation, not on the mutual fit of the parties for other tasks or knowledge.

Smart business networks however depend on the existence of reciprocity. The motivation for people and organizations to contribute to an online connected group of people or organizations who do not or hardly know each other is still an area of research. Wellman and Gulia (1999) point to different types of explanations for such motivations. The first refers to the fact that online contributions are a means of expressing one’s identity: helping others might increase self-esteem, reputation, respect from others, etc. The second one is generalized reciprocity and organizational citizenship. McLure Wasko and Faraj (2000) state that sharing knowledge and
helping others is “the right thing to do” and that people also have the desire to advance the community as a whole. Members in a smart business network may not expect to be reciprocated by the same person or organization with whom they share knowledge or transactions, but they do expect to receive future help or transactions from someone in the network. Also, contributions being via online networks are at low participation and switching costs, so there is the constant risk of network failure if active knowledge or transaction producers withdraw. Thus, smart business networks do not have three of the characteristics of social networks, which are: ongoing interaction, identity persistence, and knowledge of the previous interactions (Kollock, 1999). Smart business networks are as fragile as minimal social situations in emergent social networks.

This brings focus (for the second time after the business network consistency graph) on a characteristic of smart business networks, that is their similarity with genetic processes where the networking effect results from mutual perceived forces of attraction (or repulsion) and on evolutionary birth-life-death processes. For “A”, a user or economic agent, it is not only important to know if “A” prefers to use a particular process, but also if other agents “B” and “C” have similar preference and expectation values for the same process before they link up. In such a case, “A” may choose to access “C” via “B”, if “A” feels more attracted by “B” and if “B” and “C” have a bilateral agreement, and not necessarily set up a network involving jointly “A”, “B” and “C”. The implication of this argument is that the design of a smart business network must not only reflect the needs of individual members, but more importantly the social triadic relationships in the emerging networks and how they evolve over time (Wenger et al. 2002). If the perceived forces of attraction grow, maybe “A” and “B” will merge. If the perceived forces of repulsion grow, “A” or “C” may quit the network and it is destroyed. As to the evolution over time, two types of alternative forces may apply: either genetic conquer or divide principles, or statistical dynamics with random walks; in this last case there are relations between how far nodes in a smart business network may jiggle over time, the number and size of the nodes, and the “viscosity” and diffusion coefficient in the environment. This allows stating the usefulness of Monte Carlo simulation to analyze these effects at a statistical level.

This leads directly to proposing a representation of smart business networks, and a design method, relying on the connectiveness in genetically evolving networks, with topologies found both in the business relations space as well as in their communications network topologies. The follow-
Section 2 will discuss how this representation is routed in philosophical theories departing from those used in traditional general management.

### 2. Smart Business Networks and Emergence Theory

Emergence theory (Sober (2004), Holland (1999, 2000), Kim (1999)) is a recent line of research in philosophy and physics aiming at filling some gaps found in analytical theories of evolution. It also claims that the world is not made of assemblies of particles, components or processes interacting with each other, but instead of a large variety of objects and processes each having singular definitions and obeying each to their own rules. In this theory, the whole should be more than the sum of its parts. It is said that a property or a process are "emergent" at a given organizational level if, although in principle reducible to the properties of its constituents at a lower level (Glymour (1970)), its sudden appearance seems impossible to predict a priori from knowledge of these properties.

A special class of emerging organizations, are cellular automata which create higher level organizations when some conditions are met between their constituents; such organizations can experience chaos as well as order at times, can dissipate properties, can oscillate in synchronism, etc. ...Attraction (also called attractive) nodes are fixed or periodic or chaotic configurations towards which the evolution may go although in different ways (Berlekamp (2001), Heudin (1994, 1998)). Each is nevertheless the subject to internal as well as system-wide effects which cause the change and evolution. As an example, a bifurcation or split happens in an attractive node when a system parameter reaches a critical value creating dishomogeneity in the whole system.

The illustrative set of rules by John Conway called "game of life" (See: www.virtual-worlds.net) is:

1) If a node in state "1" is surrounded by two or three nodes in state "1", then it keeps its state
2) If a node is in state "0" and is surrounded by three nodes in state "1", then it changes to state "1"
3) In all other cases, the node switches to state "0"

Starting from a random configuration of nodes in either state "0" or "1", after some tens of iterations the population of nodes in state "1" dwindles...
fast, being replaced by new constellations of nodes with changing shapes but with some stability; some of these constellations emerge in different orientations or positions. In Section 4, a richer formalism with associated rules will be presented which is closer to the needs of business genetics.

Cellular automata governed by different sets of rules are categorized into:
- Class I: evolution towards fixed stable configurations irrespective of the initial configuration
- Class II: evolution towards stable periodic configurations, after some iterations
- Class III: evolution towards a succession of chaotic configurations, which nevertheless share a same property (e.g. the proportion of nodes in state "1")
- Class IV: evolution towards the emergence of long transitory configurations (blocks, beehives, blinkers, gliders, etc ...) with a large diversity which seem to interact with one another.

Experimentation with cellular automata allows to study self-organization phenomena, and above all, in specific domains, to elicit the set of rules which lead to different types of organizations over time. Have for example been already researched the evolution from collective oscillations to collective chaos (Nakagawa (1994)), the emergence of collective behaviour in large chaotic systems (Chate (1998)), and synchronization (Pikovsky (2001)).

The full relevance of cellular automata for smart business networks, including their dynamics, will emerge in Section 3, 4.2 and 5, but it can already be conjectured here that they offer a valuable simple formalism to analyze:
- business relations represent forces and energy, some measurable and others not, which reshape business partnerships
- the state of the business activities, instead of being just reduced to two states, can be partitioned into either finite states, or finite classes of risks
- while business deals may drive the initial engagements, a very interesting issue are the set of rules whereby they are modified or cancelled in view of sector/economy wide forces and reorganization.

But what is missing is now to relate such automata, and the emergent behaviours, with business analysis and possible representation tools helping first illustrate the smart business network dynamics, and next elicit the applicable forces or rules.
3. Smart Business Maps

A number of authors, even prior to the “smart business network” concept and theory emergence in 2004, have mapped out snapshots at one point in time of business relations; in the simplest cases they used attributed graphs (with attributes being a few one-one-one relationship measures such as purchases/sales), or in more complex cases they used multivariate causal analyses such as correspondence analysis between large sets of companies and financial results over time (Pau (1977)). Hierarchical data structures such as quadtrees suffer from the same problems as attributed graphs. All these approaches (attributed graphs, quadtrees, causal graphs) suffer from a static approach to the information as well as to the results. Attributed graphs furthermore give, to the contrary of correspondence analysis, no revelations of causal factors or business preferences explaining some key decisions. By working on time indexed information, correspondence analysis however can reveal graphically some evolutions and the drivers therefore, as exemplified in the analysis of Danish bank’s balance sheets over time (Pau (1977)). It results from these early lessons that multiple dimensions must be taken into account, but that there is a trade-off in the complexity of the analysis as well more importantly in its visualization for intelligibility.

We will use below the notion of “smart business map” to designate a visualization of the forces of attraction and repulsion (see Sections 1 and 2), each represented by one graph dimension, between several potential parties in a possible smart business network; a simple illustration is given in Figure 1.
Figure 1  Examples of dimensions in a smart business map

In a smart business map, examples of dimensions are:

Example 1 (2 dimensions): x-deviation from B to A representing the inverse of sales from B to A, while the y deviation from B to A represents the inverse of purchases by A from B

Example 2 (2 dimensions): x deviation from B to A represents the inverse of the total business notions: volume between the two parties, while the y deviation from B to A is the inverse of A’s ownership share in B

Example 3 (3 dimensions): add to Example 3 the z-deviation from B to A as the inverse in licences (number or license payments) by A to B's intellectual property rights

The notion and use of smart business maps allows in the next Section 4 to introduce computational geometry and it’s powerful rules.
4. Voronoï Diagrams and Coordination

**Figure 2** Basics in Voronoï diagrams and tessellations; the red points are the nodes; the red lines are the equi-distance Voronoï lines; the figure illustrates the insertion of a second, a third and a fourth node

**4.1 Voronoï Tessellation**

Consider a set of objects (points) in the plane. Each of these objects is to be considered to have a sphere of influence, defined as the region which is closer to that object than to any other object. The result of this zoning activity is to partition the plane into a set of polygonal regions, each region associated with a particular object. For points in the plane these polygonal regions can be shown to be convex polygons. The result of this process is referred to as a Voronoï tessellation.

While the mathematical definition is straightforward it must be emphasized that Voronoï diagrams are not at all abstract entities. This approach may be created e.g. in physics by magnetic fields, but does apply also to business processes if e.g. the distance measure is the level of business ex-
changes between two parties represented each by a point. Thus Voronoï diagrams are closely related to real physical or business processes which simplifies both the visualisation of the technique and the potential for the modelling of these processes.

Considerable research has been dedicated to studying Voronoï diagrams. While theoretical algorithms are the particular speciality of the field of computational geometry, the applications in business process management have not been explored. The efficient construction of point Voronoï diagrams in the Euclidean space has been well known for some years, but other particular Voronoï diagrams (using other metrics, furthest point Voronoï techniques, cases with boundaries, etc.) are still research issues (Preparata & Shamos 1985). As a general statement, coordinates do not of themselves produce relationships, that is: graph theoretical structures relating objects in space. This is partly due to the fact that the two branches of mathematics involved have very little overlap in these problems. Graph theoretic techniques require that relationships (adjacency relationships in particular) be previously defined, while the straightforward definition of coordinates provide no information of itself about the linkage between points and objects in space. It is here suggested that the use of a Voronoï generating process may simplify the transition from coordinate based information to graph theoretic adjacency based structures.

### 4.2 Business Genetics vs Computational Geometry

The above approach has various characteristics, which include the use of "split, grow, merge" as in cellular automata and even more explicitly in genetic algorithms, or "divide and conquer" methods to obtain the most efficient construction techniques. While the use of "divide and conquer" techniques implies the construction of the diagram for the whole data set at one time (read: the whole business network), the genetic techniques allow fundamentally the updating of the data set in the process of the application (read: the business growth or demise).

### 4.3 Implementation and Storage of Voronoï Polygons

As previously mentioned, the computational geometry approach to point Voronoï diagram generation is based on "divide and conquer" methodology, whereby the whole data set is "inserted" at once. This approach is based on the assumption that the input data will require significant small scale adjustments before it is in its final form, thus the emphasis must be on local operations for the insertion and deletion of individual points and line segments.
As the guiding principle is that adjacency of objects is defined by the adjacency of their Voronoï regions, and these regions occupy all the available two-dimensional space (read: all levels of business transactions up to the limits set by the convex regions); but the first point inserted "owns" the available universe, just like an innovative enterprise with a new product/service does. The second point is generated by the first point splitting in a cell-like fashion, or by a selection of the first business partner, the new point then moving to its final location as the business first is created. The universe now has two Voronoï cells, with a linear boundary between them. Subsequent points are formed either by cellular subdivision of a suitable nearby point, followed by local movement, or by the selection of a very remote outsider for a closer relation. The "split" operation described previously is an action that can be considered to be a division of a general polygon into two, with the generation of two adjacent dual triangles that specify the new adjacency relationships formed, or the insertion of a new node into a generalized linked list.

The "delete" operation is the reverse activity: the moving of the point to be deleted to a nearby one, followed by the "merge" of the two adjacent polygons. This again may be thought of as the deletion of their now redundant common boundary, the deletion of the two unnecessary dual triangles, or the removal of a node from the generalized linked list. We thus have a cellular life cycle: birth (split, acquire), life (move, grow) and death (shrink, merge, divest). This leads to the study of smart business network dynamics.
5. The Smart Business Network Dynamics

![Diagram: Network of nodes \(\rightarrow\) Structures such as smart business networks \(\rightarrow\) Properties

Retroaction \(\downarrow\)

Entropy \(\uparrow\)

Variation and network dynamics \(\uparrow\)

Emergence

Stabilisation

Business / « Energy » / Social forces

**Figure 3** The business drivers and rules in a smart business network, as linked to the effects in a genetic system

Section 4 describes birth and death, but what about life and its evolution? This clearly consists of movement, but any movement will change the boundaries between the moving point and its neighbouring points. For Voronoï polygons, the boundaries may readily be re-created if the neighbours are known, but this information is already stored in the dual triangulation determining the ownership to the respective polygons. Thus small movements that do not change the set of neighbours are not of particular concern and represent a stable business network. But how can we tell if the neighbourhood set needs to change, and how should it be updated? One definition of the Voronoï criterion is that the circumcircles of the dual triangulation must be empty. Expressed in another way, the centre of each of these circumcircles is the location where three Voronoï polygons meet, and thus must be equidistant from the three points or objects forming the triangle vertices. If another point falls within this circle, clearly the previous statement is untrue. Thus if the notion of the moving point takes it inside the circumcircle of an "external" triangle
(one that does not contain the moving point as a vertex.) the network must be updated. This is achieved by switching the diagonal of the quadrilateral formed by the external triangle and the moving point (making the triangle vertex that was not an immediate neighbour into one that is now), thus re-establishing the Voronoï criterion (Gold, 1978). The point is then considered to have moved precisely to the intersection of its proposed path with the circumcircle, and the next step in its travels is determined by re-examining the neighbouring triangles.

A similar process is followed for the case where the moving point leaves the circumcircle formed by triples of its immediately-neighbouring points. Again a switch of two triangles takes place, but now one of these neighbouring points ceases to be an immediate neighbour, and a newly defined triangle is "left behind".

Thus movement of a point occurs as a series of steps or jumps based on the density of neighbouring points. If we move to higher dimensions, the words "triangles" and "circles" should be updated accordingly, but otherwise the process is general. It is however limited to point objects.

The process just described is sufficient to generate a point Voronoï diagram in any metric. This means in particular that in Smart business maps (Section 3) a wide diversity of properties of business relations and organisations can be used simultaneously to analyze an evolution or elicit rules about their convergence towards a smart business network. But which notion allows taking into account the internal diversity in goals, means and processes as discussed in Section 0? This is addressed in Section 6 which shows the direct relevance to this issue of line segment objects as representations of different business divisions within a given smart business network partner.

6. Line Segment Objects and Business Divisions

Line segments are defined as the interiors of line segments, excluding their end points with remain point objects in their own right. In business terms the line segment is the continuum of enterprise groups contributing to a given product or service line (or the wished evolution over time between two positions). A star configuration describes a diversity of product lines or business divisions. The end points can form the vertices (not edges) of the dual triangulation. This dual triangulation is referred to as a Delaunay triangulation when limited to point vertices, and a Voronoï adjacency graph (VAG) when including line-segment or other vertex objects.
Since the Voronoï definition of "zones of influence" about each object, is based on which object any particular location is closest to, it is readily extendable to any type of object, and the result must be a planar graph of the polygon set, just as the VAG must also be planar.

If it is desired to create line-segment objects (read: a continuum of enterprise groups, or an evolution path), it is well known that a line is the locus of a moving point, and hence represents all the previous possible positions of the moving point. Thus a line segment is created by performing a split on its starting point which adds two new objects (a new line head plus a trailing line segment connecting the head with the tail throughout) and four new triangles. The head point is moved as before, but no switching out of previous triangles is performed, the trailing line segment retaining all these previous adjacencies. As a result of these actions, line objects may be created within the business space, either to new coordinate locations or else connecting to previously defined points.

The result of this activity is to generate Voronoï diagrams of any combination of points and line segments that may form a business universe under construction, a polygon set, a set of internal activities plus breaks for partner diversification, etc.

It appears that a large class of smart business network analysis problems, as well as their evolution may be handled through the Voronoï polygons and VAG's whose construction is described above. Note that all operations are incremental, and there is no definitive or complete data set involved, so editing can take place at any time, and polygons that fail to close at the design stage may readily be snapped together during a single pass of the VAG (read: loose partnerships are not sustainable).

7. Case from High Tech Field

The case is a snapshot of the direct implementation of earlier research reports (Pau, 2005a) (Pau, 2005b) by one of the world’s top management consultancies, to assist this research author and his team in their industry to cater to a strategic goal, i.e. turn “A", a high tech systems supplier to the service sector, into a systems and service integrator benefiting from the outsourcing trend amongst its service provider customers.
7.1 Case Specification

More precisely, the case is about designing a smart business network around the field support, installation and consulting Division of the company “A”, to allow “A” to achieve a significant worldwide market share in network operations amongst its worldwide service provider customers, at a time where these customers change their core business of running networking services into the new core business of interconnecting networks they do not want to operate themselves anymore. This can only succeed if on a global scale, “A” can identify, select, use and sever links to a wide diversity of smaller technology or skills suppliers, many of them only operating in localized markets, or having de facto only one key customer. As the outsourcing opportunities are time-critical, and as “A” wants to leverage its systems know-how (on its own products and selected other one’s), financial terms are in effect of secondary importance compared to a rather large number of intangible properties searched for or to be avoided. Very often the track record of the smaller high tech companies may have been with competitors to “A” or with “A”’s own customers without any direct connection to “A”. The potential number of partners in the total smart business network is about 500, with on a country or regional basis a minimum of three and maximum of about 15.

7.2 Discussion of the Use of Business Genetics in this Smart Business Network Design

The proposed tools for design and mapping described in the previous Sections were found extremely powerful and relevant first because of the sheer automated exhaustive handling of all possible configurations, with their evolutions over time (from known track records into fulfillment horizons on the outsourcing contracts). Next, the possibility for “A”, with help of the consulting company, to tailor the forces of attraction and repulsion (usually via simple look-up tables expressing real preferences) around mostly intangibles, was a unique advantage. Intangibles considered fell into the broad categories of: skills sets, available staff on short or medium term notice, prior systems/product/tools experience, incentives and penalty conditions, geographical distance of pockets of skills sets to the customer sites, etc. Third, was considered very valuable the ability with simple cellular automata and computational geometry tools (such as those of Table 1) to project the evolution of the smart business network under risk situations (as discussed in (Pau, 2005a)) and, even more valuable, under negotiation sessions; quick decisions could be made to stop early or to entrust a partner with a wider role, etc. Last, was judged very favourably by deci-
sion makers the use of smart business maps (see Section 3) for their support and involvement.

The drawbacks were the learning time it took for traditional management consultants to adapt to this novel way of thinking; but actually this time was far less than the time a merchant bank would have taken to tackle the same volume of analysis. The other drawback was the reluctance by some of the 500 possible parties to disclose some intangible characteristics; but actually this was never a show-stopper as information was readily available by indirect channels such as the references these same companies were citing.

The outcome parameters were KPI’s in supplying outsourcing contracts as business networks, and so far the over 10 instances have not lead to any questioning on the methodology, but rather on the changing goals and structure of the service suppliers.

It is thus considered that the methods are generazible to other domains where in depth qualitative, quantitative and financial analysis of each possible partner is not possible, due to their number or time pressure. The selection rules must be tailored, although the consulting sector may accumulate experience in this design phase.

8. Conclusion

The initial scope of this paper was to identify methodologies and tools whereby one could elicit and analyze business and organizational rules whereby smart business networks could be designed to exhibit some smartness.

It has been shown that computational geometry, although of a theoretical nature, in relation to genetic and cellular automata; provide many of the basic insights into the feasibility of various algorithms to design business networking/alliance operations between parties having no/little track records of mutual interactions. It has also been shown above that smart business maps (relying on computational geometry, with business metrics as feature space dimensions), help decision making in the design phase, and allow comparing the actual business performance over time amongst a network of business parties. Individual business parties financial accounts and market achievements do not represent sufficient performance indicators across a smart business network.
This design approach though does not make sense when there is in depth track record of interactions, or human knowledge about the same, or “political” biases in the selection process, cases which anyway usually drift towards much less dynamic smart business network structures.

On the theoretical side, the inability of computational geometry algorithm in providing exact line intersections leads to the weakness of not guaranteeing consistent business network topologies, except with considerable care. In such cases cellular automata, especially of classes III and IV, although more demanding numerically, can provide more robust business and organizational rules.

Finally on the practical implementation side, experiments have started to use the proposed tools and design methodology in the case of content distribution networks driven by instantaneous end user requests and profiles. Here parties have no track record of interaction and their number is much larger, besides the issue that payments must be secured under such circumstances sometimes on a real-time per-request basis. Such a case represents the challenge in the real time design of real time smart business networks!
<table>
<thead>
<tr>
<th>Smart business network design rules , using Voronoi diagram representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Polygons are formed from interconnected vertices And edges. In order for a polygon to be topologically complete Pointers must exist between vertices (if defined) and edges. The resulting region on the graph must then be labelled</td>
</tr>
<tr>
<td>2. All vertices (nodes) in a polygonal business map can be forced to have a valence of three by creating an imaginary zero-length edge and splitting the original node.</td>
</tr>
<tr>
<td>3. The dual of a modified polygon set is a triangulation, where all polygons are represented by nodes and all vertices have become triangles. The original arbitrary boundaries between adjacent polygons are replaced by triangle edges representing an adjacency relationship between polygons.</td>
</tr>
<tr>
<td>4. Triangulations may readily be stored as fixed length records storing the three vertices, the three adjacent triangles and, if required, the three bounding edge record numbers for each triangle.</td>
</tr>
<tr>
<td>5. An alternative to a triangulation as a basic record type is a line segment. This is also of fixed length, storing pointers to the two end vertices and the two (anticlockwise) adjacent line segments. Both line segments and triangulations are valid data structures whose relative advantages are minor and depend on the application.</td>
</tr>
<tr>
<td>6. Triangulation in this context expresses relationships between triples of objects, mostly polygons.</td>
</tr>
<tr>
<td>7. If triangulations express adjacency relationships between points (the duals of polygons) the dual triangulation is an appropriate expression of the adjacency relationships between Voronoi polygons and is thus an expression of the adjacency relations between h original generating data points.</td>
</tr>
<tr>
<td>8. The objects associated with the triangle vertices need not be points: they may be any objects, e.g. points plus line segments.</td>
</tr>
<tr>
<td>9. The Voronoi criterion for any object is defined the same manner as for points, and may readily be calculated. Boundaries may be line segments or parabolas.</td>
</tr>
<tr>
<td>10. The boundaries between Voronoi polygons are implicit in the relationship between any two adjacent vertices (objects) in the triangulation, and need not be preserved. The centre of the triangle (i.e. the junction between three Voronoi boundaries) is more critical in determining which boundaries are to be preserved to form the triangulation.</td>
</tr>
</tbody>
</table>
11. Basic operations for linked lists are: initialize; insert; delete; search; and switch. The equivalent for triangulations are: initialize (create a bounding triangle to enclose the data set); search (walk through the triangulation to find the bounding triangle for the point or object); insert (split the bounding triangle into three to accommodate the new object); switch (interchange the diagonal on adjacent triangle pairs—performed if the Voronoi criterion is not met for the current triangle pair); delete (remove an object from the triangulation by temporarily merging two adjacent objects and deleting the two redundant triangles: the reverse of insert).

12. The switch operation is performed whenever the common boundary between two adjacent triangles does not conform to the Voronoi criterion. For four points in isolation the Voronoi criterion guarantees that the one or other of the two ways of dividing the quadrilateral into triangles will be valid.

13. The “insert” and “delete” operations are equivalent to “split” and “merge” operations on objects. This permits the hierarchical organizing of objects into a tree structure if required, for efficient organization or searching. This is most easily understood if the dual of the objects (a polygon set) is considered; in this mode, two adjacent polygons A and B are merged into polygon AB.

14. Interpolation may be performed by the judicious insertion and deletion of dummy sampling points in order to determine the relative areas of the adjacent Voronoi polygons stolen by the new dummy point.

15. Line segments are constructed from their two end points and a connection link. If these end points and the line segments are inserted into the Voronoi network they will each generate their own Voronoi region. For line segments connected to form a polygon, the interior boundaries of these regions form the skeleton or medial axis transform of the polygon in vector space.

16. Any triangulation may be processed as an oriented binary tree with respect to some viewpoint, permitting front-to-back or radially-outward ordering of objects on a business map. This is of use in contour construction, hidden line or surface removal, and the searching for all nearest neighbours within some tolerance.

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Report Parallel Session B

Reporter: Joris Hulstijn

The session combined two representatives of the industry, with presentations on topics ranging from the possible impact of the 'semantic web' on Smart Business Networks, to the application of mathematical techniques.

Parallel Session B1: “On the Impact of Service Science on Smart Business Networks”

Presenter: Geleyn Meijer (LogicaCMG)

The transition towards a services based society calls for a ‘science of services’. There is a lot of uncertainty about the transition from supply chains to networks. For example, in a network it is unclear who is boss. Standard contracts are no longer directly applicable. And liability has been distributed. Instead of outsourcing on a fixed description, as before, external companies are more treated as partners, to help and innovate. But again, this leads to uncertainty regarding legal issues.

An initiative for the development of knowledge and software for network organizations, is Nessi: the “Networked European Software and Services Initiative” (www.nessi-europe.com). It involves both politicians and industrial partners. The mission is to set up a list of best practices on service oriented utilities, and investigate new application domains.

In the discussion, Mr Sanz asks about the “commitment behind the words”. Examples of successful applications work best to convince people. Mr Pau points out that there is an inconsistency between talk of sharing and developing open standards, while software companies keep standards proprietary. Mr Pau also asks what would constitute a proper ‘service science’? For example, we still lack a definition of what constitutes a service.

Parallel Session B2: “Building Smart Business Networks”

Presenter: Paul Brackel, (HR-XML Platform)
Mr Brackel combines years of experience in supply-chain management at Unilever, with involvement in Plein-U: an initiative to develop an XML standard for human resource management application, called HR-XML. He has formulated some generalizations.

First, the food industry tends to have a very long supply chain, with many parties and sub-contractors. At the boundaries between domains new opportunities for clever cooperation arise. Because the chain is long, there are many such boundaries. Second, the computer industry or car industry require relatively wide supply chains, because their products are complex. Hence, we find many opportunities for smart collaboration. Third, the temporary job market tends to have a rather short supply chain. There is fierce competition, in relatively local or specialized markets. Hardly any collaboration is found. This supports the hypothesis, that sector characteristics determine the opportunities for smart business networks. In particular, the characteristics are: length of value chain, width of value chain, complexity of products/services and market scale.

Afterwards we discussed what makes an SBN smart? One of the answers is the possibility to quickly connect or disconnect. The kind of XML standard developed at Plein-U, would support easy connectivity. Another aspect is the willingness to share knowledge or business processes. Apparently, in the temporary job market, there are no incentives to share or collaborate more.

Parallel Session B3: “Semantically Enabled Service Oriented Architectures: a driver for Smart Business Networks”

Presenter: Hannes Werthner (Technical University of Vienna)

The presentation begins with an example from tourism. Consider a network that tries to bundle the services of about a 100 hotels, with ski facilities. The idea is that rules for assembling a package deal must be decided. How can such a negotiation process be supported? The requirements are autonomy of the participants, dynamism, coordination facilities, models of the technical, the economic, and the trust level, and robustness.

On the one hand, a lot of relevant research is being done on web-services and technical infrastructure. On the other hand, there is work on formal ways to specify business models, for example with value webs. The challenge is to bridge the gap, with semantically enriched tools. The proposal is to use the Semantically Enabled Service-oriented Architecture
(SESA), as a conceptual model for the development of SBNs. SESA has three layers: a problem-solving layer, a common services layer and a resource layer. Each of these layers is applied to common problems that surround the inception of a SBN: partner selection, contracting, technical integration and process composition.

In the discussion, the question comes up how much of the creation of SBNs we want to automate. The modest answer is that the technology should only be a support. Leadership is often needed. You cannot automate trust, and especially the creation of the governance structures requires human interaction. Mr Meijer suggests, by analogy with virtual organizations, that before a network can get started, a breeding phase is needed, in which potential participants may get to know each other. Still, intelligent tools for finding potential partners, for drafting standardized contracts, and business process composition, are necessary.

**Parallel Session B4: “Establishing Service-Oriented Business Operations: A Step wise Analysis of Challenges and Solutions”**

*Presenter: Samuli Pekkola (University of Jyvaskyla)*

The paper deals with a case study, about the relationship between large paper mill, and a paper making machine manufacturer. This is an industry with a very large capital investment in a very few machines. Currently, the machine manufacturer is trying to move towards a service-oriented business model, focusing on consulting services regarding the maintenance of the paper mill. It appears that the mill factory, that bought the machine, is unresponsive because it has financial pressures, minimizes preventative maintenance, and hires services from many individuals as and when needed. Paper machines are complex. The paper demonstrates that there are clear gaps in the communication between the manufacturer, and the paper mill, and it appears that this is an example of a Smart Business Network being unachievable. This appears to be the diametric opposite of the paper by Xavier Busquets.

In the discussion, Paul Brackel suggests that this is quite a common problem. Even with a services oriented model, the supplier has very few potential customers.
Parallel Session B5: “Smart Business Networks Design and Business genetics with a High Tech Industry Case”

Presenter: Louis Pau (Ericsson, RSM Erasmus University)

A new development in the telecommunication industry is the advent of virtual operator. Telecom operators increasingly act only as marketing brands, getting a license from a governmental body. The day-to-day operation of the network is contracted out for a fixed price. Ericsson is quite successful in this market, thanks to what might be called a Smart business Network, which manages the sub-systems of other providers, and helps with partner selection.

The idea is to select a set of partners to deliver parts of the contract, on the basis of a ‘finger print’, which not only involves financial information, but also intangible aspects like expertise and skills. The approach to selecting the set of partners makes use of Genetic Programming. The algorithm represents the forces of attraction and repulsion between partners, clustered in an abstract space. So called Voronoi Tessellations are used to find planes that separate clusters of potential partners, on the basis of partner ‘fingerprints’. This clustering technique is robust, and can handle dynamics.

In the discussion, it becomes clear that the crux of the model lies in the tables that specify design rules for a ‘good’ smart business network in a domain. Clearly, Ericsson will not allow publication of such knowledge. The suggestion of the Chairman is therefore to invent a limited but non-trivial application, with simplified design rules, in order to illustrate the use of the technique. The result of the business case can then be shown without details, as evidence of the practical usefulness of the approach.
16. Strategic Sales Management Guided By Economic Regimes

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Abstract

We present methods to characterize market conditions from historical data, and we describe how this knowledge can be used to make strategic and tactical sales decisions. The methods are based on learning dominant market conditions, such as over-supply or scarcity, from historical data using computational methods to represent the price density function. We show how to use this knowledge, together with real-time observable information, to identify the current dominant market condition and to forecast market changes over a planning horizon. We validate our methods by presenting experimental results in a case study, the Trading Agent Competition for Supply Chain Management.

1. Introduction

Business organizations have an increasing need for software that can assist decision makers by gathering and analyzing information and making recommendations and business decisions. Advanced decision support systems and autonomous software agents promise to address this need by acting rationally on behalf of humans in numerous application domains. Examples include procurement [1, 2], scheduling and resource management [3, 4], and personal information management [5, 6].

14 Partial funding is acknowledged from NSF under grant IIS-0414466.
The approach we present in this paper is based on using machine learning algorithms to support rational decision making by an autonomous agent that operates in a supply chain environment. In our method we characterize market conditions by distinguishable statistical patterns, that we call regimes. We show how such patterns can be learned from historical data and identified from observable data. We outline how to identify regimes and forecast regime transitions. This prediction, in turn, can be used to allocate resources to current and future sales in a way that maximizes resource value. While this type of prediction about the economic environment is commonly used at the macroeconomic level [7], such predictions are rarely done for a microeconomic environment.

We use a competitive trading environment, the Trading Agent Competition for Supply Chain Management [8] (TAC SCM) as a testbed for our methodology. TAC SCM is a market simulation in which six autonomous agents buy parts, assemble personal computers, and sell them to consumers in daily auctions.

A TAC SCM agent must base its decision on how to allocate its resources and how to set prices using limited information about the state of the market and the strategies of the other agents. Agents must simultaneously compete in two separate but interrelated markets: the market from which the agents must buy their supplies and the market to which the agents must sell their finished products. Agents have a large number of decisions to make in a limited time, so computational efficiency of the decision-making process is essential. Therefore, TAC SCM is an appropriate and comprehensive testbed for our methodology.

Although in this paper we present regime identification, prediction, and resource allocation in the context of TAC SCM, our method is applicable to other domains, both for autonomous decision making by an agent and as a decision support technology. Examples of domains to which our proposed approach can be applied include agents for automated trading in financial markets, such as the Penn-Lehman Automated Trading Project [9], auction-based contracting environments, such as MAGNET [10], and other auctions, such as auctions for IBM PCs [11] or PDA’s on eBay [12].

After a review of relevant literature, we describe in a general way the information needed to make strategic and tactical sales decisions. We follow with a discussion of the concept of “economic regimes” and their representation using learned probability density functions. We then describe how this method is used in an automated trading agent. For reader’s convenience, we present a summary of our notation in the Appendix.
2. Related Literature

Massey and Wu [13] show in their analysis that the ability of decision makers to correctly identify the onset of a new regime can mean the difference between success and failure. Furthermore they found strong evidence that individuals pay inordinate attention to the signal (price in our case), and neglect diagnosticity (regime probabilities) and transition probability (Markov matrix), the aspects of the system that generates the signal. Individuals who do not pay enough attention to regime identification and prediction have the tendency to over- or underreact to market conditions.

In [14] the authors empirically analyze the degree to which used products cannibalize new product sales for books on Amazon.com. In their study they show that product prices go through different regimes over time. Marketing research methods have been developed to understand the conditions for growth in performance and the role that marketing actions can play to improve sales. For instance, in [15], an analysis is presented on how in mature economic markets strategic windows of change alternate with long periods of stability.

Much work has focused on models for rational decision-making in autonomous agents. Ng and Russel [16] show that an agent’s decisions can be viewed as a set of linear constraints on the space of possible utility (reward) functions. However, the simple reward structure they used in their experiments will not scale to what is needed to predict prices in more complex situations such as TAC SCM.

Sales strategies used in previous TAC SCM competitions have attempted to model the probability of receiving an order for a given offer price, either by estimating the probability by linear interpolation from the minimum and maximum daily prices [17], or by estimating the relationship between offer price and order probability with a linear cumulative density function (CDF) [18], or by using a reverse CDF and factors such as quantity and due date [19].

All these methods fail to take into account market conditions that are not directly observable. They are essentially regression models, and do not represent qualitative differences in market conditions. Our method, in contrast, is able to detect and forecast a broader range of market conditions. Regression based approaches (including non-parametric variations) assume that the functional form of the relationship between dependent and independent variables has the same structure. An approach like ours that models variability and does not assume a functional relationship provides more flexibility and detects changes in relationship between prices and sales over time.
An analysis [20] of the TAC SCM 2004 competition shows that supply and demand (expressed as regimes in our method) are key factors in determining market prices, and that agents which were able to detect and exploit these conditions had an advantage.

3. Sales Strategy

We assume that a rational agent will attempt to maximize its profit. In an environment where production capacity and component supplies are limited, sales must be focused on getting the highest possible prices for the resources the agent has available over some planning horizon. Suboptimal sales decisions may result in a situation where inventory is sold out during a period when prices are low, leaving the agent with nothing available to sell later when prices are higher.

Typically, an agent makes sales decisions in two steps. The first step is a strategic decision, where resources are allocated over a planning horizon in a way that maximizes expected profit. The second step is a tactical decision, which determines the prices that are expected to sell the quantities determined by the strategic decision, given the current customer demand and pricing model. In this paper we focus primarily on the strategic decisions.

Figure 1 gives a high-level architecture of the components involved in making sales decisions.
As illustrated, some data are expected to be external to the agent and observable in the market. This includes things such as daily price reports, data on customer demand, and data on sales made recently. Some information, such as inventory status, resource constraints, and cost basis, is expected to be internal to the agent and not directly visible to any other agent. Some information is expected to be derived by the agent using its own prediction methods.

The two major components that are used for decision making are the “Economic Regime Model” and the “Allocation” modules. The “Economic Regime Model” uses current and past sales data to predict regimes and price density of the goods to be sold over some time horizon. The “Allocation” module sets the quantity (sales quota) the agent wishes to sell through some time horizon. The decision is made taking into account resource constraints, current inventory status, cost basis, and expected demand. This can be done, for example, by solving a linear program that maximizes the total profit over the selected horizon and over the set of finished goods that the agent can potentially sell. If the agent can predict the approximate market price for each product to be sold in the planning horizon, then it can compute the predicted profit per unit of good.
4. Economic Regimes

Market conditions change over time, and this should affect the strategy used by an agent in procurement, production planning, and product pricing. Economic theory suggests that economic environments exhibit 3 dominant market patterns: scarcity, balanced, and over-supply. We define a scarcity condition if there is more customer demand than product supply in the market, a balanced condition if demand is approximately equal to supply, and an over-supply condition if there is less customer demand than product supply in the market. When there is scarcity, prices are higher, so the agent should price more aggressively. In balanced situations, prices are lower and have more spread, so the agent has a range of options for maximizing expected profit. In over-supply situations prices are lower. The agent should primarily control costs, and therefore either do pricing based on costs, or wait for better market conditions.

We believe that even though the market is constantly changing, there are some underlying dominant patterns which characterize the aforementioned market conditions. We define a specific mode a market can be in as a regime. A way of solving the decision problem an agent is faced with is to characterize those regimes and to apply specific decision making methods to each regime. This requires an agent to have methods for figuring out what is the current regime and for predicting which future regimes will be in its planning horizon.

4.1 Analysis of historical data to characterize market regimes

The first phase in our approach is to identify and characterize market regimes by analyzing data from past sales. The assumption we make is that enough historical data are available for the analysis and that historical data are sufficiently representative of possible market conditions. Information observable in real-time in the market is then used to identify the current regime and to forecast regime transitions.

Since product prices are likely to have different ranges for different products, we normalize them. We call np the normalized price and define it as follows:

\[
np = \frac{ProductPrice}{NominalProductCost}\frac{ProductPrice}{AssemblyCost + \sum_{j=1}^{numParts} NominalPartCost_j}
\]

where NominalPartCostj is the nominal cost of the j-th part, numParts is the number of parts needed to make the product, and AssemblyCost is the
cost of manufacturing the product. An advantage of using normalized prices is that we can easily compare price patterns across different products.

Historical data are used to estimate the price density, $p(np)$, and to characterize regimes. We start by estimating the price density function by fitting a Gaussian mixture model (GMM) to historical normalized price, $np$, data. We use a GMM since it is able to approximate arbitrary density functions. Another advantage is that the GMM is a semi-parametric approach which allows for fast computing and uses less memory than other approaches. We use the Expectation-Maximization (EM) Algorithm [21] to determine the Gaussian components of the GMM, $N[\mu_i, \sigma_i](np)$, and their prior probabilities, $P(ci)$. The density of the normalized price can be written as:

$$ p(np) = \sum_{i=1}^{N} p(np|ci) P(ci) $$

where $p(np|ci)$ is the i-th Gaussian from the GMM, i.e.,

$$ p(np|ci) = p(np|\mu_i, \sigma_i) = \frac{1}{\sigma_i \sqrt{2\pi}} e^{-\frac{(np-\mu_i)^2}{2\sigma_i^2}} $$

where $\mu_i$ is the mean and $\sigma_i$ is the standard deviation of the i-th Gaussian from the GMM. An example of a GMM is shown in Figure 2. While the choice of $N$, the number of Gaussians', in a GMM is arbitrary, the choice should reflect a balance in derived accuracy and computational overhead. We chose $N = 10$, because we found experimentally that this provides good quality. We tried other values, ranging from 5 to 15, with similar results.
Using Bayes’ rule we determine the posterior probability of the i-th Gaussian of the GMM given a normalized price, \( np \), as follows:

\[
P(c_i|np) = \frac{p(np|c_i) P(c_i)}{\sum_{i=1}^{N} p(np|c_i) P(c_i)} \quad \forall i = 1, \cdots, N
\]

We then define the posterior probabilities of all Gaussians’ given a normalized price, \( np \), as the following N-dimensional vector:

\[
\eta(np) = [P(c_1|np), P(c_2|np), \ldots, P(c_N|np)].
\]

For each normalized price \( np_j \) we compute the vector of the posterior normalized price probabilities, \( \eta(np_j) \), which is \( \eta \) evaluated at each observed normalized price \( np_j \).

We cluster these collections of vectors using the k-means algorithm. Each cluster corresponds to a regime. The center of each cluster is a probability vector that corresponds to regime \( r = R_k \) for \( k = 1, \cdots, M \), where \( M \) is the number of regimes. Collecting these vectors into a matrix yields the conditional probability matrix \( P(c|r) \). The matrix has N rows, one for each component of the GMM, and M columns, one for each regime.

In Figure 3 we distinguish five regimes, which we can call extreme over-supply \( (R_1) \), over-supply \( (R_2) \), balanced \( (R_3) \), scarcity \( (R_4) \), and extreme scarcity \( (R_5) \). Regimes \( R_1 \) and \( R_2 \) represent a situation where there is a glut in the market, i.e. an over-supply situation, which depresses prices. Regime \( R_3 \) represents a balanced market situation, where most of the de
mand is satisfied. In regime $R_1$ the agent has a range of options of price vs sales volume. Regimes $R_4$ and $R_5$ represent a situation where there is scarcity of products in the market, which increases prices. In this case the agent should price as close as possible to the estimated maximum price a customer is willing to pay.

For the TAC SCM domain, the number of regimes was selected a priori, after examining the data and looking at economic analyses of market situations. In our experiments we found out that the number of regimes chosen does not significantly affect the results regarding price trend predictions.

The computation of the GMM and k-means clustering were tried with different initial conditions, but consistently converged to the same results.

We marginalize the product of the density of the normalized price, $n_p$, given the $i$-th Gaussian of the GMM, $p(n_p|c_i)$, and the conditional probability clustering matrix, $P(c_i| R_k)$, over all Gaussians $c_i$. We obtain the density of the normalized price $n_p$ dependent on the regime $R_k$:

$$
p(n_p| R_k) = \sum_{i=1}^{N} p(n_p|c_i) P(c_i| R_k).\n$$

The probability of regime $R_k$ dependent on the normalized price $n_p$ can be computed using Bayes rule as:

$$P(R_k| n_p) = \frac{p(n_p|R_k) P(R_k)}{\sum_{k=1}^{M} p(n_p|R_k) P(R_k)} \quad \forall k = 1, \ldots, M.
$$

where $M$ is the number of regimes. The prior probabilities, $P(R_k)$, of the different regimes are determined by a counting process over past data.
Figure 3 depicts the regime probabilities for a sample market in TAC SCM. Each regime is clearly dominant over a range of normalized prices.

The intuition behind regimes is that prices communicate information about future expectations of the market. However, absolute prices do not mean much because the same price point can be achieved in a static mode (i.e., when prices don’t change), when prices are increasing, or when prices are decreasing. In the construction of a regime the variation in prices (the nature, variance, and the neighborhood) are considered thereby providing a better assessment of market conditions.

The last step is the computation of a Markov transition matrix to be used by the agent for regime prediction. We model regime prediction as a Markov process. We construct a Markov transition matrix, $T_{\text{predict}}(r_{t+1}|r_t)$ by a counting process over past data. This matrix represents the posterior probability of transitioning at time step $t + 1$ to regime $r_{t+1}$ given the current regime $r_t$ at time step $t$.

**4.2 Identification of current regime**

Previous sales data are used to learn the characterization of different market regimes. In real-time an agent can then use this regime information to identify the dominant regime. This can be done by calculating (or estimating) the normalized prices for the current time step, $t$. Since complete current price information might not be available, we indicate the estimated normalized price at time $t$ by $\hat{p}_t$. Depending on the application domain, the price estimate can be accurate, or can be an approximation. The agent selects the regime which has the highest probability, i.e.

$$\arg\max_{1 \leq k \leq M} P(R_k|\hat{p}_t).$$

**4.3 Regime prediction**

The prediction of regime probabilities is based on two distinct operations:

1. a correction (recursive Bayesian update) of the posterior probabilities for the regimes based on the history of measurements of the estimated median normalized prices obtained since the time of the last regime change until the previous time step.
2. a prediction of regime posterior probabilities for the current time step. The prediction of the posterior distribution of regimes $n$ time steps into the future is done recursively.
The agent can use the regime identification and the forecast of regime transitions to adapt its procurement, production, and pricing strategies accordingly.

5. A Case Study: TAC SCM

The Trading Agent Competition for Supply Chain Management [8] (TAC SCM) is a market simulation in which six autonomous agents compete to maximize profits in a computer-assembly scenario. The simulation takes place over 220 virtual days, each lasting fifteen seconds of real time. Agents earn money by selling computers they assemble out of parts they purchase from suppliers. Each agent has a bank account with an initial balance of zero. The agent with the highest bank balance at the end of the game wins.

To obtain parts, an agent must send a request for quotes (RFQ) to an appropriate supplier. Each RFQ specifies a component type, a quantity, and a due date. The next day, the agent will receive a response to each request. Suppliers respond by evaluating each RFQ to determine how many components they can deliver on the requested due date, considering the outstanding orders they have committed to and at what price. If the supplier can produce the desired quantity on time, it responds with an offer that contains the price of the supplies. If not, the supplier responds with two of-
fers: (1) an earliest complete offer with a revised due date and a price. This revised due date is the first day in which the supplier believes it will be able to provide the entire quantity requested; and (2) a partial offer with a revised quantity and a price with the requested due date. The agent can accept either of these alternative offers, or reject both. Suppliers may deliver late, due to uncertainty in their production capacities. Suppliers discount part prices according to the ratio of supply to demand.

Every day each agent receives a set of RFQs from potential customers. Each customer RFQ specifies the type of computers requested, along with quantity, due date, reserve price, and penalty for late delivery. Each agent may choose to bid on some or all of the day’s RFQs. Customers accept the lowest bid that is at or below the reserve price, and notify the winning agent. The agent must ship customer orders on time, or pay the penalty for each day an order is late. If a product is not shipped within five days of the due date the order is canceled, the agent receives no payment, and no further penalties accrue.

An agent can produce 16 different types of computers, that are categorized into three different market segments (low, medium, and high). Demand in each market segment varies randomly during the game. Other variables, such as storage costs and interest rates also vary between games.

The other agents playing in the same game affect significantly the market, since they all compete for the same parts and customers. This complicates the operational and strategic decisions an agent has to make every day during the game, which include how many parts to buy, when to get the parts delivered, how to schedule its factory production, what types of computers to build, when to sell them, and at what price.

5.1 Experimental setup

For our experiments, we used data from a set of 24 games (18 for training and 6 for testing) played during the semi-finals and finals of TAC SCM 2005. The mix of players changed from game to game, the total number of players was 12 in the semi-finals and 6 in the finals.

Since supply and demand in TAC SCM change in each of the market segments (low, medium, and high) independently of the other segments, our method is applied to each individual market segment.

15 3694@tac3, 3700@tac3, 4229@tac4, 4234@tac4, 7815@tac5, 7821@tac5, 5638@tac6, 5639@tac6, 3719@tac3, 3720@tac3, 3721@tac3, 3722@tac3, 3723@tac3, 4255@tac4, 4256@tac4, 4257@tac4, 4258@tac4, 4259@tac4 – To obtain the complete path name append .sics.se to each game number.

16 3717@tac3, 3718@tac3, 3724@tac3, 4253@tac4, 4254@tac4, 4260@tac4
Each type of computer has a nominal cost, which is the sum of the nominal cost of each of the parts needed to build it. In TAC SCM the cost of the facility is sunk, and there is no per-unit assembly cost. We normalize the prices across the different computer types in each market segment.

5.2 Online identification of current regime

Every day the agent receives a report which includes the minimum and maximum prices of the computers sold the day before, but not the quantities sold. We use the mid-range price, \( np \), the price between the minimum and maximum, to approximate the mean price. This approximation sometimes is quite poor. An example which shows how the mid-range value differs from the mean value is in Figure 5. The mean value is computed after the game, when the entire game data are available. We observe that the mid-range price is different from the mean price. In this example, around day 40 and occasionally beyond day 120, we observe a high spike in the maximum price. This was caused by an opportunistic agent who discovered a small amount of unsatisfied demand, but most of that day’s orders were sold at a much lower price. To get a better approximation, we apply a double exponential smoother on the mid-range price. Figure 5 shows that the smoothed mid-range price, \( \tilde{np} \), is closer to the mean price.

![Figure 5. Minimum, maximum, mean, mid-range, and smoothed mid-range daily normalized prices of computers sold. All prices except the mean are computed from the data reported during the game every day. The mean price is computed after the game using the game data, which include complete information on all the transactions. Data are for the high market segment in 42570tac4, one of the final games.](image)

During the game, the agent estimates on day \( t \) the current regime by calculating the smoothed mid-range normalized price \( \tilde{np}_{t-1} \) for the previous
day (recall that the agent every day receives the minimum and maximum
prices for the previous day) and by selecting the regime which has the
highest probability, i.e. \( \arg \max_{1 \leq k \leq M} P(R_k | \pi_{t-1}) \).

Figure 6 shows the relative probabilities of each regime over the course
of a game. The graph shows that different regimes are dominant at different
points in the game, and that there are brief intervals during which two
regimes are almost equally likely. An agent can use this information to de-
cide which strategy, or mixture of strategies, to follow. When making deci-
sions the agent should consider not only the current regime (tactical deci-
sion), but also upcoming regime changes (strategic decision). Therefore an
agent needs to predict future regimes.

![Figure 6](image)

**Fig. 6.** Regime probabilities over time computed online every day for the high market
segment. Data are from game 4257@tacl.

### 5.2 Regime prediction

Since in the context of TAC SCM each time step corresponds to a single
day we train the Markov matrix, \( T_{\text{predict}}(r_{t+1} | r_t) \), on regime changes from day
t to day \( t + 1 \) by a counting process over past games. The correction and
prediction steps are applied to the current regime probabilities as outlined
in Section 4.3. Examples of regime predictions for a sample game for the
high market segment are shown in Figure 7 and Figure 8.

The figures show the real regimes measured after the game from the
game data and the predictions made by our method during the game. As it
can be seen in the figures, the match between predictions and real data is
very good. Figure 7 shows a predicted change from extreme-scarcity to
scarcity. In this case the agent should try to sell more aggressively the cur-
rent day, since prices will be decreasing in the next days. On the other
hand we see in Figure 8 a change from an extreme-oversupply situation to an oversupply situation. This means that the agent should sell less today and build up more inventory for future days when prices will be higher.

We have reported in [22] and [23] a correlation analysis of the market parameters to regimes and more details on regime identification and prediction.

### 5.4 Tactical Sales Decision

The regime model we have described can help the agent to make strategic decisions that can drive procurement, production, and sales behaviors. We now briefly outline how our agent makes tactical sales decisions.

Given the daily sales quotas, price trend predictions, and the current demand for each product, the final tactical decision is to set the offer price for each product to a value that is expected to sell the desired quota. We assume that the computed price is offered for the entire demand. This is done with the help of a pricing model that approximates the probability that customers will accept an offer at a given price. The agent uses a simple linear approximation, given the expected median price (derived from $\Pi^f$ and from a feedback loop that monitors the agent’s sales performance) and slope of the acceptance probability function. Offer prices are slightly randomized, and actual sales performance is used to update the model.
6. Conclusions and Future Work

We have presented an approach for identifying and predicting market conditions in markets for durable goods. We have demonstrated the effectiveness of our approach using games played in the semi-finals and finals from TAC SCM 2005. An advantage of the proposed method is that it works in any market for durable goods, since the computational process is completely data driven and that no classification of the market structure (monopoly vs competitive, etc) is needed.

Our approach recognizes that different market situations have qualitative differences that can be used to guide the strategic and tactical behavior of an agent. Unlike regression-based methods that try to predict prices directly from demand and other observable factors, our approach recognizes that prices are also influenced by non-observable factors, such as the inventory positions of the other agents.

Our method promises to enable an agent to anticipate and prepare for regime changes, for example by building up inventory in anticipation of better prices in the future or by selling in anticipation of an upcoming oversupply situation. In future work we plan to apply our method to data from Amazon.com or eBay.com.
7. Appendix: Summary of Notation

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
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<tbody>
<tr>
<td>np</td>
<td>Normalized price</td>
</tr>
<tr>
<td>np'</td>
<td>Mid-range normalized price</td>
</tr>
<tr>
<td>npi</td>
<td>Smoothed mid-range normalized price</td>
</tr>
<tr>
<td>p(np)</td>
<td>Density of the normalized price</td>
</tr>
<tr>
<td>GMM</td>
<td>Gaussian Mixture Model</td>
</tr>
<tr>
<td>N</td>
<td>Number of Gaussians of the GMM</td>
</tr>
<tr>
<td>p(np</td>
<td>ci)</td>
</tr>
<tr>
<td>μi</td>
<td>Mean of i-th Gaussian of the GMM</td>
</tr>
<tr>
<td>σi</td>
<td>Standard deviation of i-th Gaussian of the GMM</td>
</tr>
<tr>
<td>P(ci)</td>
<td>Prior probability of i-th Gaussian of the GMM</td>
</tr>
<tr>
<td>P(ci</td>
<td>np)</td>
</tr>
<tr>
<td>ηi(np)</td>
<td>N-dimensional vector with posterior probabilities, P(ci</td>
</tr>
<tr>
<td>M</td>
<td>Number of regimes</td>
</tr>
<tr>
<td>R_k</td>
<td>k-th Regime, k = 1,⋯,M</td>
</tr>
<tr>
<td>P(ci</td>
<td>r)</td>
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<tr>
<td>p(np</td>
<td>R_k)</td>
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<tr>
<td>P(R_k</td>
<td>np)</td>
</tr>
<tr>
<td>t</td>
<td>Current time</td>
</tr>
<tr>
<td>t_n</td>
<td>Time of last regime change</td>
</tr>
<tr>
<td>T_{\text{prune}}(r_{n+1}</td>
<td>r_n)</td>
</tr>
</tbody>
</table>

References


17. Smart Business Networks and their IT Infrastructure: A Framework to Evaluate IT Investments

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Abstract

Interorganizational systems (IOS) are a strategic factor for inter-firm networks. IOS investment decision makers face two specific evaluation problems: unclear benefit sharing amongst the partners and risk for opportunist behavior. To increase these uncertainties, we are presenting a framework which identifies the impact of different Property Rights diffusions among network partners on their costs and benefits for specific IOS investments.

Keywords: IT investments, new institutional economics, Enterprise Application Integration

1. Introduction

To coordinate the cross-company processes in so called smart business [42] or inter-firm networks [13], they typically have to implement interorganizational information systems [32], [36]. Prominent examples for such IOS in networks are Supply Chain Management Systems to accelerate the exchange of inventory and demand data (e.g. the Systems of Baan, Oracle or SAP [3]) or EDI-Applications to support the interorganizational exchange of business documents [9].

While implementing IOS in a smart network, all involved partners face classical investment problems such as project uncertainty and the specificity of the investment object. Special problems arise because of intentions and actions of every single network partner. Uncertainties of the partners (concerning actions and potentials) and opportunity costs are the major factors for network-specific investment risks [41]. Traditional ways of measuring the business value of information systems such as IT evaluation
frameworks or IT governance approaches are problematic when applied in a collective setting [29]. Typically, they focus on the depicted classical investment issues without considering network-specific investment problems. For example, when investing into relationship-specific, cooperative infrastructure, investors face extraordinary risks. Nevertheless, Star Alliance, founded in 1997, is already at its second major IT infrastructure project, the so-called Common Platform. Even if the airlines were able to calculate their individual return on investment for the new project, in which respects would the new infrastructure change major organization economic problems (such as specific risks) for the investors?

We try to examine these specific evaluation problems with the help of the Property-Rights theory. Following a qualitative approach to comparative economic organization analysis (see [44]), primarily we are presenting the outlines of the underlying theoretical framework and a short description of the methodology. Afterwards we supply a theory-geared analysis of the investment problems. The theoretical findings are forming the basis for interpreting two different IOS investment scenarios of the airline network Star Alliance.

2. Approach

As indicated in the introduction, collective investments are subject to a number of organization-related specifics. For example, the actions and intentions of the partnering investors are not known and can lead to opportunistic behavior on their side. Generally, however, the relevant actors’ behavior is described differently depending on the theoretical framework chosen [14]. In regard to business networks and inter-firm cooperation, several approaches such as Actor-Network theory [19], [38], structuration theory [12], [37] or systems theory [23] were drawn on to explain these dynamics. According to Luhmann’s systems theory, for instance, trust represents the overarching moderating element in social systems – such as business networks. The New Institutional Economics, on the other side, assumes individual utility maximization and opportunistic behavior – and even believes that business networks are not a form of organization in itself but rather a hybrid conglomerate of market- and hierarchy-based elements [39]. We believe that both the individual utility maximization and the hybrid nexus of contracts assumptions are more appropriate when giving management guidance on giant investments. Therefore, the new institutional economics are chosen as our frame of reference.
From this perspective, both the risk for opportunism and the unclear allocation of costs and benefits can be regarded as the major obstacles in deciding on collective investments. For example, as Williamson ([44], p. 121) suggests, trading parties will only invest into relationship specific assets if appropriate safeguards are in place (such as functional collective governance) or the risk for opportunism is low. The risk for opportunism, however, varies with the organization of the investment. On the other side, Clemons and Kleindorfer ([5], p. 433) specified the problem from an IOS perspective: “the central question in these applications would appear to be how surplus is generated by an IOS and how this surplus is shared amongst participants to the IOS”. An IOS investment typically being relationship-specific (see [22]), both opportunistic information behavior [2] and the difficulty of monetarily valuating IT costs and benefits [26] will not allow for a reliable, interorganizational assessment of the asset. So how can partners figure out whether they get an adequate deal?

When approaching these problems from an objective perspective, several parts of the new institutional economics (NIE) can be of help. The NIE represent a school of thought in economics which focuses on the role of institutions such as contracts, markets, hierarchies, legal systems and so on for productivity: “in effect, it is the institutions that govern the performance of an economy, and this gives the ‘new institutional economics’ its importance for economists” ([6], p. 73). While the NIE have also faced harsh criticism regarding its assumptions which neglect informal restraints and presume unethical behavior [28], [1], several of its interdependent theoretical components can prove useful to an analysis of the investment problems described above.

Principal-Agent theory, for example, deals with opportunistic scopes for action held by contracting agents. Regarding the unclear distribution of net benefits, Property-Rights (PR) theory could provide useful insights as “the main allocative function of property rights is the internalization of beneficial and harmful effects” ([8], p. 350). This allocative function is of particular importance to the problem at hand as one Airline’s use of the common infrastructure will not only affect its own utility (internalized costs and benefits) but also the utility of others (external harmful and beneficial effects). The risk for opportunistic behavior as such provides an advanced example of internalized and external effects: while an Agent derives additional utility from his real option to behave opportunistically, the Principal has to calculate this risk as a cost. The assumption is that only if an actor is directly and fully affected by his own actions, he will use assets efficiently. This, however, only happens when all property rights are fully allocated. The allocation of property rights, though, is costly: during generation, allocation, assignment and enforcement of property rights, actors incur trans-
action costs [11]. These costs rise exorbitantly for full allocations and therefore a full allocation is considered to be unfeasible. Still, property rights theory allows insights into where potential costs and benefits can accrue.

In regard to the methodology used in organization economic analysis, the general aim of such investigations is relative, not absolute comparison [44], [30]. Therefore, it is not monetary quantities we wish to measure, but the values of relevant attributes. The process of such qualitative approaches can be clearly sketched into four steps (see [44], p. 5 and p. 27):

1. transferal of reality to theory (“translation”)
2. description of alternative organizational modes (“scenario building”)
3. comparative evaluation of alternative modes (“structured qualitative analysis”)
4. aggregation of the results (“aggregation”)

3. Developing a framework

We follow with the subsequent analysis and start with step 1.

Step 1: Translation

Property-Rights theory fundamentally allows deducting how specific costs and benefits will be allocated to actors – this way PR theory predicts the behavior of economic actors [17], [15]. The moderating variable is the diffusion of property rights amongst them. When translating the reality of collective investments into theoretical parlance, we hence have to clarify the three dimensions (1) diffusion of property rights, (2) costs and (3) benefits.

1. When considering the diffusion of property rights of an asset, we have to make clear which partial rights to look at. Traditionally, three rights are distinguished: ius usus, ius abusus and ius fructus ([10], p. 1140). The usus right grants the holder the right to use an asset, abusus denotes the owner’s privilege to change an asset at his discretion and fructus represents the owner’s liability to internalize all resulting effects (beneficial and harmful). The diffusion of property rights can now take on two forms: either the three rights themselves are diffused as wholes and/or the individual rights are shared [29]. In many cases all investors officially bear all rights – therefore the three rights are distributed and shared. As this is the case, investments into relationship specific IT infrastructure represent col-
lective investments which imply a number of severe problems to asset owners (e.g. free riding, over use, see [4]; see also discussion in step 3). On the other hand, collectivity is not an absolute fact – it can also be seen as a continuum (from fully private to fully collective, see [11]). Therefore, the relative diffusion of the rights in the two infrastructures to be compared has to be determined. Based on the restricted enforceability of the partial rights by the individual owners, this rating is conducted in step 2.

(2) We have to keep in mind that comparative economic organization analyses will not lead to absolute but to relative appraisals. Still, categorizations typically used for gathering absolute figures can be of help. Regarding the IT cost side to investments, the total cost of ownership (TCO) approach offers a relatively comprehensive systematization of cost factors (for an overview see [24]). It discerns direct costs for hardware and software and indirect costs including administration downtime and colleague support. As indicated, however, these lists are not complete. Three major factors are not considered by the TCO: opportunity cost, complexity cost and risk. In IOS investment, opportunity costs (the not chosen alternative’s return) can take on two forms. First, by investing into the relationship specific asset, a partner has opportunity cost over joining a different alliance. Second, when choosing one investment (e.g. common exchange standard), other options (such as a collective database) are not pursued. Complexity and hence complexity costs rise with the number and the decentrality of systems [7], [24]. Investment risks, as calculated in any formal evaluation of investment options, are not considered at all.

On the other hand, investors face investment specific organization costs. First, there are transaction costs for handling property rights: as specified above, they occur during allocation (generation, allocation and assignment) and enforcement (control & enforcement). Second, in collective investment, investors are confronted with information asymmetries and opportunistic behavior by the other partners. To reduce these asymmetries, investors will engage in monitoring the other partners and will at the same time conduct bonding (e.g. signaling intentions). By monitoring and bonding, stakeholders try to enforce their rights. Nevertheless, investors incur risk costs for the other partners’ behavior (from the partners’ hidden intentions, the so-called ‘hold up’ risk and from their hidden action and information, also known as the ‘moral hazard’ risk).

Hence, when considering the costs of investing into IOS, we have to analyze IT related costs and organization related costs. IT related
costs can be direct (TCO) and indirect (TCO + opportunity costs + opportunity costs). Organization related costs are composed of costs for allocation of property rights, costs for enforcement of property rights in the form of monitoring and bonding and risk costs for the so called hold up and moral hazard risks.

(3) In the same tune, beneficial effects can also be differentiated into IT related and organization related. Organization related benefits are especially derived by lower transaction costs between the partners when delivering the collective service (a major driver for the establishment of IOS, see [16]) and by considering the real option value for opportunistic behavior (real options represent the value of flexibility in one’s actions, see [40]). The categorization and monetarization of IT related benefits has long been discussed and yielded different specialized models. In essence, however, two types of benefits can be discerned: operational and strategic benefits.

Step 2: Scenario building

Building different investment scenarios can be accomplished by analyzing the discriminating variable – the diffusion of property rights. Therefore, the diffusion of the three rights will be analyzed for different investment scenarios. For that reason, the major stakeholders have to be identified first: We distinguish active and passive investors and we assume that these groups are homogeneous in respect to the property rights they factually hold. As the diffusion of property rights indicates the potential for realizing certain benefits, it is therefore imperative to relatively compare the level of concentratedness of property rights in the scenarios. All partners nominally hold all rights – usus, abusus and fructus seem to be fully diffused. However, as Stein ([35], p. 304) indicated, there is a stark contrast between de jure and de facto rights: active investors “mistake delegated duties for personal rights and political office for ownership”. Hence, in some cases, rights which are officially diffused are more concentrated than it seems. The matter is to what extent a stakeholder can socially enforce his rights.

Step 3: Structured qualitative analysis

In this third step, the allocation of costs and benefits to the stakeholders within an investment scenario has to be analyzed in detail. As indicated, the height of the effects is measured in relative, not absolute terms. As a support construct, we choose to lean on Williamson’s ([44], p. 113) terminology negligible (0), some (1) and considerable (2) to scale the effects.
Step 4: Aggregation

In this final step, the values identified in the preceding section have to be accumulated. As stated before, the analysis deals with relative, not absolute figures. Therefore, costs and benefits were discussed and recorded in a relative fashion and can now be used for a comparison of cost/benefit relations analyzed scenarios.

4. Applying the Framework: The Case of Star Alliance’s IT investments

The airline network Star Alliance, a network founded by Air Canada, Lufthansa, SAS, Thai Airways International and United Airlines, is one of three major global airline alliances. After years of ever tighter cooperation, the five founding partners officially launched their cooperation under the label Star Alliance on 14 May 1997 which has since expanded to a 16 member network spanning 139 countries with 15,000 daily flights and 380 million annual passengers. In order to collectively supply services to end consumers and without the possibility of merging the companies (mostly due to regulatory obstacles such as flag carrier concepts, see [27] for an overview), the network had to find ways of efficiently coordinating the provision of their services. In effect, this coordination task is primarily assumed by systems which link the individual airline’s IT based applications. This case example, reconstructed from 110 official press releases [34], a Star Alliance Chief Executive meeting presentation [33] and a supplier case study [31], briefly describes these systems.

In 2000, Lufthansa Systems (Lufthansa’s IT subsidiary) and Elandtech (acquired on 1 August 2003 by IT service company SITA) completed their efforts on a communication platform which later became known as StarNet. StarNet, a Star Alliance project lead managed by Air Canada, Lufthansa and United Airlines, was developed as a system to interconnect existing applications and database of old and new Star Alliance members and ran up total costs of just under 100 million US$. Based on this communication platform, a number of small, cooperation-specific applications (such as cross-airline air miles redemption availability checks) were introduced in the form of web services in the following years. The core investment, however, was the communication platform StarNet itself.

Starting 2001, major changes to Star Alliance’s business strategy were put forward. The first landmark was the creation of a new management organization. From November 2001, Star Alliance launched a much more stable structure which now consisted of a supervisory Star Alliance board,
an Alliance Management Team and a Chief Executive Board (where the ‘owners’ of the individual airlines get together). These changes were to take place in particular regard to strengthening common customer processes and raising efficiency. As the basis for high quality, flexible service processes in large number situations lies in IT support, an adequate system had to be provided.

While all airlines already were in possession of specialized systems, the technologies underlying these systems partly dated back to the early 1970s. The solution seemed evident: all independent members update their infrastructures and applications but stress the openness of the individual systems so that the applications could easily be logically integrated. This way, the participating organizations remained strategically relatively independent – which reflected the financial and legal separateness of the individual airlines. In the end the Alliance, with members Lufthansa and United Airlines taking the lead, decided on a plan to create a new IT platform to allow flexible communication between the existing airline applications – but also to build centrally held, collectively used applications for basic airline operations: the Common Platform project.

Figure 1 depicts the likely architecture of the Common Platform, which seems to be based on an EAI concept but is strengthened by common applications which might well be implemented in a Web Service fashion. While all basic operations are now supported by centrally held IT applications, all differentiators remain under the control of the individual airlines. Own systems include customer databases, analytical applications such as yield management and management information systems. The Common Platform is set to be implemented at Lufthansa and United Airlines until the end 2007, with expansion to other airlines being planned. A final note on the suppliers: while the IT service firm Amadeus is going to support the development of the system, Lufthansa Systems (Lufthansa’s IT subsidiary) is likely to run it [25].
While the general idea of the two systems lies in the integration of distributed business processes (see [43], [21] or [20]), the case for implementing the Common Platform seems to be clear: the technology upgrade will lead to shorter development cycles and higher quality service, economies of scale come into effect when migrating all partners’ IS and additional benefits can be generated by realizing Star Alliance’s global air travel network strategy.

In the following, we will apply the framework of chapter three to examine Star Alliance’s two IT investment scenarios. Therefore, we are analyzing the diffusion of the property rights for active and passive investors as (Step 1 and 2) as well as their corresponding cost and benefits within both different investment scenarios (Step 3 and 4).

In both scenarios, the usus right itself is not concentrated at all. In both Scenarios every partner owns the IOS (by paying for the system and by membership in the network). Typically, there would be no way to exclude a partner from using the system – while this would be technically possible (the more centralized the architecture, the easier), there is no formal way of exclusion before the end of the cooperation contract. Relatively speaking,
however, the usus right seems to be fairly evenly distributed in both cases. The abusus and the fructus right, on the other hand, can be regarded as fairly more concentrated with the lead (active) investors in the Common Platform case, as they would rather benefit more from any changes to the IOS as the passive investors. They now de facto lie more with the active investors (lead partners) than with the passive investors (all other airlines).

The different diffusion of property rights for active and passive investors influences their costs and benefits (accumulated as net benefit) within both scenarios. Hence, due to restricted free riding possibilities within the Common Platform scenario for passive investors, primarily low net benefit for active investors increased considerable. Also, the net benefit for passive investors within the Common Platform scenario rose noticeable, as they benefit from negligible moral hazard and hold up options of the active investors [for details see [18], p. 163-177]. Figure 2 depicts all cost and benefits results of the two investor types within both scenarios in an aggregated manner. Interpreting this figure it is assumable, that StarNet was a trust building measure where the lead partners allowed a fair amount of free riding to take the passive investors in. The Common Platform, offering a far better net benefit relation to lead partners than StarNet, can be regarded as a natural successor to the first platform but would at the same time not have been possible without it.
5. Conclusion

Following a strict four step process of operationalisation, we focused the problems of cost and benefit allocation between the partners and the risk for opportunistic scopes of action. Regarding the theoretical background, our argumentation was based on concepts from the New Institutional Economics, namely Property-Rights and Principal-Agent theory. The analysis culminated in the aggregation of individual cost and benefit factors realized by two stakeholder groups (lead/active investors, passive investors). Applying the framework on the Star Alliance case we showed that StarNet can be regarded as a necessary test before Star Alliance was able to step up to Common Platform.

In similar projects in the future, management teams might want to give more attention to the topics of allowing free riding and opportunism testing. As the analysis showed, the relative cost-benefit distribution amongst
the partners was unfavorable for the lead partners in the beginning but still the first project was pursued. At the same time, it might be sensible to first observe partners’ behavior in terms of opportunism before stepping up to major projects.

References


18. Performance Evaluation within a Networked Enterprise: Balancing Local Objectives and Network Relations

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Abstract

Measuring the performance of a company within a network of companies is neither a simple nor straightforward activity. In a networked enterprise, aside from traditional performance indicators based on quantifiable (physical) metrics, it is also important to capture performance measures denoting the quality of customer and partner relations. These factors are, however, much harder to quantifiably measure and compare. Furthermore, it is challenging to utilize a relationship performance measure as part of a decision support mechanism. This is due to the fact that connecting the measure to a meaningful business strategy can be difficult. This paper shows how the domain knowledge of experts regarding performance can be modeled using fuzzy logic. We further demonstrate that this modeled knowledge can be used to develop business strategies based on both quantitative metrics and less tangible satisfaction measures. This approach is applied within the freight logistics domain to illustrate how the knowledge of human planners may be captured to strengthen vehicle routing decision support systems.

Keywords Performance Evaluation, Decision Support System, Networked Enterprise, Logistics, Fuzzy Logic, Business Strategies
1. **Introduction**

In their 1994 review of logistics performance literature, Chow *et al.* indicate that while multiple methods exist for both qualitative and quantitative evaluation of logistics performance, few methods exist to assess performance in settings with a multiplicity of goals [1]. This theme is similarly documented in Krauth *et al.*, in which the need to include multiple points of view in the performance measurement of logistics systems is motivated from the observation that in many cases there are conflicting needs and desires of all parties involved [2]. A basic example is that of a service provider who prefers to charge high prices and deliver a low-cost service in contrast to a customer who desires a low price and a high-quality service. One instance in which a formalized mechanism is proposed in order to balance financial and non-financial results across both short- and long-term horizons is that of the balanced scorecard [3]. The development of the balanced scorecard must, however, be undertaken by managers and is thus capturing only a snapshot of management’s perceived critical measures. As businesses move towards complex network structures it is even more important that the measures on which company performance is evaluated incorporate multiple performance dimensions.

As indicated by the balanced scorecard construct, decisions within a company should not be (and usually are not) based solely on performance metrics like costs and benefits. Although many things can be definitively measured, a large number of indicators may not be measured in a straightforward way. Usually, the trade-off between direct or measurable costs and benefits against intangible benefits such as the satisfaction of other companies in the network (and also employees within the company) is understood by the human planners alone. Over years of experience, these planners learn the preferences of all the involved business entities. This paper establishes a framework to incorporate expert knowledge in order to measure the performance of a company or business entity with multiple business partners and relations.

The remainder of this paper is organized as follows: the next section presents the background and some pertinent literature on the history of multi-dimension evaluation constructs and fuzzy logic mechanisms to model human reasoning. Section 3 describes the evaluation framework. In Section 4 we present the vehicle routing problem and the application of the evaluation framework to this vehicle routing case. Finally, in Section 5, the paper concludes with a discussion of the case study and directions for future research.
2. Background

Kaplan and Norton [4] argue that multiple performance measures are required to manage an organization. Through the introduction of strategy maps [5] they extend the balanced scorecard as a means by which to translate a strategy into a comprehensive and useful overview of business performance involving a mix of financial and non-financial measures. They consider a strategy to be a set of hypotheses about cause and effect, such as: “If we improve our logistics services then our customers will be more satisfied.” Ultimate effects usually are in terms of financial performance, such as cash flow. One shortcoming of the strategy map approach by Kaplan and Norton is the company-centric view the map engenders. While different perspectives (i.e., financial, customer, internal, and learning and growth) are included, the relationships and business meaning of these perspectives are extracted only from the viewpoint of the company performing the analysis. A well-constructed balanced scorecard should incorporate performance measures that represent critical cause and effect relationships across a wide array of stakeholders.

A system of performance measures is subject to a large number of explicit and hidden dependencies requiring simultaneous consideration. For example, one needs to balance the costs of keeping an inventory with the availability of products to meet service requirements. Success in this task may depend on investments in IT infrastructure and advanced control mechanisms – possibly implemented for other reasons. A performance measurement system in a networked environment must meet additional challenges due to the influence of multiple stakeholders. Indeed, meaningful metrics need to be defined for a network (possibly as an extension of the supply chain [6]). Moreover, one needs to address local optimization behavior by considering intra- and inter-organizational coordination systems [7].

A partial view on enterprise performance may result in biased decision making with possibly undesired effects. As indicated above, optimizing individual performance while neglecting system-wide performance may result in poor decisions. The discussion of performance measurement in networked organizations is different and in principle more complicated than the local or myopic case. Even in a coordinated system, such as a supply chain, the challenge of deriving robust performance measures may be significant [3]. A bias towards specific “hard” performance metrics (i.e., readily quantified measures) may cause the neglect of critical, but difficult to quantify, satisfaction measures, such as customer satisfaction. If such a bias is propagated the customer relationship may deteriorate. It is relevant
to note that in a network, many so-called “hard” metrics may coincidentally capture some satisfaction elements.

Furthermore, a proper understanding of the cause and effects between hard metrics and satisfaction measures is critical. For example, consider the cause and effect relationship: “If my trucks arrive on time at the customer’s then my customer will be satisfied”. This cause and effect relationship proposes a positive relationship between timeliness of trucks at the customer site and customer satisfaction. Most people will agree with the proposal, but as such it does not provide a managerial lever to improve customer satisfaction through improving truck timeliness. There are several ambiguities present in the cause and effect relationship as indicated.

First, the customer could have measured the timeliness of trucks in terms of average amount of minutes too late, where minutes too early are neglected. The customer may just as well base her satisfaction on an extreme case or on the delivery last week. In other words, the customers’ appreciation may be associated with a so-called derived aggregate measure from the set of measurements of all deliveries, explaining her level of satisfaction. Second, the level of satisfaction itself is a “soft” measure that may be expressed in an ordinal scale. Each individual may respond in a different way, not only based on the actual state (e.g. level of satisfaction), but also on the understanding of the measure (e.g. what “good” stands for).

Within this paper we recommend a framework designed to capture hard metrics and extract from them soft measures for each actor in a business network. For example, in our case study of vehicle routing, key performance indicators are designated across all stakeholder groups. These metrics are then rendered into satisfaction measures via a satisfaction evaluation component built for each of the three classes of drivers (more generally this could be employees), customers, and society. Note that “managers” are treated as a special case given their specific business rules. Generally, it is difficult to model satisfaction of all these parties properly, due to the vague (verbal) boundaries of the evaluation classes (e.g. “good”, “ok”, “bad” service). To tackle such issues, we propose the use of fuzzy logic for the design of the satisfaction measures.

Fuzzy logic applies fuzzy set theory in the design of control systems. Originally it was proposed by Lotfi Zadeh [8] for data processing and it gained wide recognition through successful applications only later. Admittedly, early uses of fuzzy logic were limited. However, with the advent of modern computing fuzzy logic has seen an increase in attention by the research community. One example of an early application of fuzzy logic may be seen in the 1977 paper by Bass and Kwakenaak in which they apply fuzzy logic to the problem of choosing between multiple alternatives.
Fuzzy logic belongs to the field known as generalized information theory [11]. Generalized information theory refers to the area of research aimed at extending classical notions of uncertainty to broader mechanisms for handling uncertainty based information. Uncertainty theory is an outgrowth of the fields of logic and probability theory [12]. Formal logic is concerned with the truth of propositions; for example, the truth of the statement: “Event A occurred.” Probability theory on the other hand is concerned with the likelihood that a proposition takes one truth value over another; for example, “There is a 60% chance that event A will occur.” Melding and extending both fields, we obtain fuzzy logic – a field concerned not with the truth or likelihood of an outcome, but rather the extent of that the outcome can be considered true [13]. Thus, fuzzy logic is well suited to measuring satisfaction – measuring to what extent the customer is happy.

The appeal of fuzzy logic is the ability to express verbal performance descriptions by so-called membership functions. These membership functions may then be combined via fuzzy rules to obtain an output set. These fuzzy rules can represent expert knowledge to express relations between both soft factors and hard measures. Finally, in a step usually called “de-fuzzification”, the output set can be used with a pre-defined function to derive a single score denoting, in this paper, a level of satisfaction.

The objective of this paper is to illustrate a new evaluation framework by which networked organizations may evaluate their performance; a framework that allows one metric to be viewed not only as a quantifiable measure, but also as a reflection of satisfaction experienced by network partners. This approach is premised on a careful selection of performance metrics along with the conversion of such metrics into satisfaction measures. The selection of performance metrics is undertaken with a robust view of the organization – including metrics of importance across multiple stakeholder groups. The conversion of these metrics to a measure of satisfaction is achieved through the application of fuzzy logic. This proposed framework is illustrated through a case in vehicle routing at a mid-sized logistics service provider.

3. The Evaluation Framework

Our evaluation framework is premised on the assumption that hard metrics may capture the performance of a company in a networked setting, but only from the standpoint of one party in the network. Such measures fail to
capture the satisfaction of all parties, and hence the sustainability of the company or business entity in a networked setting. As such, we have, at the core of our evaluation framework, a mechanism for the extraction of satisfaction measures from hard metrics.

This section presents the evaluation framework as a four-step process. These four steps are: stakeholder identification, key performance indicator (KPI) identification, construction of fuzzy rules to derive satisfaction scores, and application of the framework to the company or business entity under evaluation. Following the application of the framework to a business entity, it is necessary to ensure that the model is behaving as expected and is updated frequently to reflect reality; hence, the feedback arrow. This evaluation framework may be viewed in Figure 1.

Figure 1 Overview of steps in constructing the evaluation framework.

When judging company performance in a large network of players, it is important to evaluate the company in a multi-dimensional manner from the perspective of all stakeholders. The first step in the evaluation process is to identify all of the stakeholders. To facilitate this step we utilize the stakeholder categories described in Krauth et al.[2]. These categories are management, employees, customers, and society. Within these large classifications there may be one or more specific stakeholder groups that should be specifically designated. For example, in the category of employees there may be multiple stakeholder groups such as drivers, maintenance personnel, dispatchers, etc.
Once all stakeholder groups have been identified, a list of key performance indicators should be constructed for each stakeholder group. There are several approaches towards identifying performance indicators relevant to individual stakeholders and the overall system. The derivation of a balanced scorecard of KPIs (as discussed in Section 2) is an example of a structured top-down approach. It is also possible to use a semi-structured bottom-up approach where individual stakeholders are asked to identify their individual KPIs. In particular, stakeholders are asked to highlight those performance measures that are key indicators of their satisfaction with the performance of the organization under evaluation within the network. Clearly, this bottom-up approach is challenged with the requirement that it should be feasible to actually measure the KPIs put forward. Note that each stakeholder group will have one or more KPIs, and that if no logical KPI has been defined for a stakeholder group, then that stakeholder group should be removed from the set of stakeholders. Both the top-down approach and the bottom-up approach may result in the inadvertent exclusion of system-wide KPIs when no system-wide stakeholders are identified. It is therefore a prerequisite to the development of KPIs to identify stakeholders that represent a diverse set of objectives including system-wide objectives (e.g. management).

Following the construction of the KPI lists it is necessary to capture the meaning of each metric in terms of stakeholder satisfaction. To achieve this we recommend the use of fuzzy logic. In addition to the history and reasoning presented in the literature review, this recommendation is premised on the need for a mechanism that:

1) can accommodate expert knowledge described in simple English;
2) can be readily modified as perceptions change;
3) can accept multiple inputs;
4) can accept imprecise or ambiguous information; and
5) can aggregate multiple inputs across time and business entities.

The use of fuzzy logic is a three step process requiring the definition of fuzzy sets for each KPI for each stakeholder group; the construction of fuzzy rules to combine multiple fuzzy measures; and finally the definition of defuzzification functions to translate the fuzzy result into a quantifiable score. For a more detailed exposition of these three steps, the reader is advised to look in a text book on fuzzy logic; for example, “A First Course in Fuzzy Logic” by H.T. Nguyen and E. A. Walker [10], or see for example the extensive description at Wikipedia.org.

Fuzzy sets in effect allow the translation of a quantified metric into a verbal description of performance or satisfaction – i.e. “good”, “ok”, or “bad”. Making this translation allows the meaning of a hard metric to be
captured in a unique manner for each stakeholder. For example, considering the case of schedule deviation, in the context of order delivery, some customers may rate their satisfaction as “good” if an order arrives two minutes late. However, if the order is ten minutes late they may consider their satisfaction to be “bad”; but in the case of five minutes late this may fall into the verbal “gray area” somewhere between “good” and “ok”. Thus, fuzzy sets must be carefully considered for each stakeholder and KPI combination. The fuzzy sets may be constructed by considering expected set shape and membership or through a process of discovery based on the careful observation of satisfaction in relation to performance metrics.

After fuzzy sets have been constructed, fuzzy rules must be defined to merge all “fuzzified” metrics into a single fuzzy measure of satisfaction. In order to use this fuzzy measure as part of an aggregate score with non-fuzzy metrics, the final step of the fuzzy logic process is “defuzzification”. In this way we can move from a perception of satisfaction to a quantifiable representation of satisfaction. Note that the satisfaction measure emerging from this process is very different from the hard metric used as input. For example, in vehicle routing, management prefers that the metric “driver idle time” be kept low; a high driver satisfaction score is, however, dependent on a high idle time. In this way fuzzy logic forces a company to see the value of a single metric in multiple dimensions.

Once all component parts of the evaluation framework have been defined, as listed in steps one through three, the framework should be implemented to determine the score of the company or business entity in its networked business setting. In this framework, the final output is the quantified hard metrics and the satisfaction measures for each stakeholder group. This list of scores may, however, be difficult for management or decision makers to use in a business setting. Therefore, in the application of the defined evaluation framework, the final score is taken to be the linear combination of the score assigned to the various stakeholder groups (the equation for the final score may be seen in Figure 7, Section 4.2.4). Weights are assigned to each component of the linear combination in order to reflect the relative importance of each stakeholder in the eyes of the company under evaluation.

To illustrate the use of this evaluation framework we apply it to a specific case in the freight logistics domain. The following section, Section 4, provides the details of this case and demonstrates how the evaluation framework may be tailored to such a setting.
4. Application of the Evaluation Framework

In this section we demonstrate how the evaluation framework set out in Section 3 may be tailored to the specific case of vehicle routing. We first provide some detail on the vehicle routing case under examination and then follow with a description of how the evaluation framework may apply.

4.1 Description of the Vehicle Routing Case

We illustrate our approach in the transportation domain. The primary task of a transportation company, often referred to as a logistics service provider (LSP), is to pickup goods from one location – generally a supplier – and to deliver them to another location – generally the customer. The LSP works directly for either the supplier or the customer. While delivering the goods efficiently is an important factor in the success of such a company, it certainly is not the only important factor. Most notably, the maintenance of good relations with customers, suppliers and sub-contractors is critical to the survival of such a company. In this section we first define the problem of delivering goods efficiently as it has been used in many optimization tools thus far, and after that, we describe the specific vehicle routing case used in this paper.

Inherent in the freight transportation industry are problems of fleet management. Chief among these problems is the vehicle routing problem (VRP) – the challenge of devising efficient routes to collect from and deliver to a set of locations. Given the prevalence of this problem in industry the VRP has been extensively studied. Ball et al [14], for example, provide a comprehensive survey of this research field.

Assume that the following are given:
- a set of vehicles (usually initially located at a starting location called the depot, or the home base of the drivers) with a certain capacity, and
- a set of orders with a certain size, consisting of a pickup and a delivery location, and often also with a pickup and delivery time window.

What then is the best allocation of orders to vehicles, and in which order should the vehicles visit the pickup and delivery locations, such that all orders are executed while minimizing the traveled distance? As noted before, besides minimizing the direct costs by minimizing the traveled distance, there are other important factors:
- the satisfaction of each of the customers that gave the orders (and will give more orders in the future),
the satisfaction of the employees, and
the satisfaction of society (which may also be seen as potential customers).

In practice, such a problem is not static, but changes continually. Not only new orders may arrive, but orders may change, or vehicles may get delayed or even break down. To test our framework, we study a specific case of this problem.

Researchers from the RSM Erasmus University, the TU Delft, the Free University Amsterdam, and the Center for Applied Mathematics and Computer Science (CWI) are working together with industrial partners Post-Kogeko, Vos Logistics, Almende BV, and CarrierWeb on the application of agent-based technologies to the vehicle routing problem. Specifically, decision support systems are developed to support the transport of containers over the road by LSP Post-Kogeko. Post-Kogeko is a mid-size LSP active in a several sectors, one being the transport of import and export containers, generally of the merchant haulage type. Post-Kogeko has a fleet of around 40 trucks active in this sector, handling around 100 customer orders each day.

The process of executing an order starts with the reception of an order, generally one day before required execution. An order is a customer request to Post-Kogeko for pickup and transport of a specific container from a container terminal (in case of an import container) to the customer, with delivery within a certain time window. Arriving at the customer’s requested location, the container is then unloaded, and the empty container is brought back to a container terminal or empty depot – depending on the contract the customer has with the ocean carrier or shipping agent. This concludes the order, and the truck is ready for its next order. The process is reversed for export containers. What complicates matters is that not all containers are available at the start of operations early in the morning: either they have not physically left the ship yet, or they are delayed for administrative reasons – often due to an unsettled payment or customs. Post-Kogeko can only transport containers that have been released, and are allowed to leave the container terminal. For this reason it is hard to optimize the system in a traditional sense, since not all information is known beforehand, and will only become available sometime during the day. A large variance in the work per day, i.e., the number of orders per day and the distance to travel per order, further complicates the planning process.

The planning and control of operations is currently performed manually by a team of three human planners, who take care of the order intake, the capacity planning for the next day – which means arranging the proper amount of trucks based upon required workload, and the assignment of
currently executing orders to trucks. Given the primarily manual method of operations, the addition of a decision support system may greatly benefit the profitability and scalability of Post-Kogeko’s operations. Researchers from the above mentioned academic institutes are working on three different agent based decision support systems for this highly dynamic case of the vehicle routing problem. To determine which system performs the best in a simulated setting, we propose evaluating the simulation output for these three systems using both traditional or hard metrics (e.g. empty distance traveled) and soft or satisfaction measures (e.g. customer satisfaction).

4.2 Evaluation Framework for the Vehicle Routing Case

Recalling the four-step evaluation framework construction process detailed in Section 3, this section describes the construction and application of the evaluation framework used in the specific problem of vehicle routing. It is important to emphasize that the application presented here is as an example of the four primary framework steps; this paper does not explore methods for calibration. This section is divided into four subsections organized around the four framework steps.

4.2.1 Step 1: Identification of Stakeholders

Using the four general stakeholder classifications identified in Krauth et al. [2], a careful consideration of the stakeholder groups within each category was undertaken. Considering the vehicle routing problem, within the management category only the managers for the company owning the fleet of vehicles to which the routing decision support system will be applied are considered. The category of employees could encompass many stakeholder groups within the context of the vehicle routing problem. In this example, however, the framework is restricted to only one stakeholder group – drivers. This decision was made based on the understanding that the drivers will be the most impacted by the plan emerging from the routing decision support system. Additionally, driver retention is often stated as a management goal; hence, it seems that accounting for their satisfaction is important. In practice each customer would be treated differently, receiving their own set of rules (or adaptation of a master set). In this case study, however, there is only one customer stakeholder group defined as all of the companies contracting with the fleet management company for the delivery of a container to/from the Port of Rotterdam. Finally, society in this case is considered to be all citizens impacted by the performance of the vehicle routing company. Thus, the following four stakeholder groups emerge: Management, Drivers, Customers, and Society.
4.2.2 Step 2: Identification of Key Performance Indicators

In developing a list of KPIs for each stakeholder group, the output of the vehicle routing decision support system is first carefully considered. The output is expected to include an archive of the routing plan and what occurred during execution. Considering this output, and utilizing a top-down approach, all measures that can be derived from such output are listed; the KPIs identified in the paper by Krauth et al. [2] served as a basis for this listing. Once this preliminary list was constructed, the focus became a bottom-up approach – focusing on each stakeholder group, assigning to them the KPIs from the list that were considered most important and brainstorming additional KPIs that may have been previously overlooked. This process yielded ten metrics of importance; a depiction of the KPIs and how they are split across the four stakeholder groups may be seen in Figure 2.

4.2.3 Step 3: Definition of Satisfaction via Fuzzy Logic

As described in Section 4.1, the modeling of satisfaction is done through the use of fuzzy logic. Defining a fuzzy model requires selecting sets to model fuzzy concepts, defining connectives to combine measures via rules, and choosing a defuzzification procedure. This process can be tedious as it must be repeated over all the KPIs and for each of the stakeholder groups. As such, this section presents only the KPIs affiliated with the stakeholder group, “Drivers”, as an example of constructing a fuzzy model; the fuzzy sets and rules for all ten KPIs may be viewed in Appendix A.
Step 3a) Selecting sets to model fuzzy Concepts.

In considering the satisfaction of the four stakeholder groups the first step is to consider how each group might rate their experience with one KPI. In this example this first step of set construction is simplified by considering only a limited number of linguistic terms – “good”, “ok”, and “bad”. Note, throughout this paper the following ordering is assumed: good is better than ok, and ok is better than bad. The key step now is to construct the membership functions of these fuzzy terms for each KPI. Also, note that not all KPIs map to all three linguistic terms, some KPIs map only to good or bad with no descriptor for ok. This is justified as there are some measures that people would only classify as good or bad and never ok. For example, when considering order rejections in the eyes of the customer any level of rejections above zero will be bad; no rejections would be good.

Looking at the first Driver KPI, driver idle time, the three functions $D_{1,g}(x), D_{1,o}(x), D_{1,b}(x)$ are constructed. These functions take the total hours of driver idle time normalized by the total number of hours the driver is on duty, $x$, and return the value of the function $D_{1,g}, D_{1,o}, D_{1,b}$. This value represents the degree that $x$ falls into the verbal categories, “good”, “ok”, and “bad”, respectively. In practice the structure of these functions may be derived via a combination of expert opinion and common sense, or even automatically learned and updated. In this example, however, for simplicity’s sake all functions are assumed to be of a triangular form.

In the case of vehicle routing, driver idle time is defined as any time the driver is on duty, but not at a customer location and not driving. This measure is then normalized by the total number of hours the driver is on duty. Further, it is assumed that the drivers prefer more idle time over less idle time. Using these assumptions combined with the assumption of triangle membership functions, we obtain the following functional forms; depicted graphically in Figure 3.

$$D_{1,g}(x)=\begin{cases} 0 & \text{if } x \leq .5 \\ 2x & \text{if } .5 < x \leq 1 \end{cases} \quad D_{1,o}(x)=\begin{cases} 2x & \text{if } 0 < x \leq .5 \\ 2 - 2x & \text{if } .5 < x \leq 1 \end{cases} \quad D_{1,b}(x)=\begin{cases} 1 - 2x & \text{if } 0 < x \leq .5 \\ 0 & \text{if } .5 < x \end{cases}$$
Similarly, the membership functions, $D_2(x)$ and $D_3(x)$, are constructed for the remaining two Driver KPIs: the number of plan deviations and the geographic range of driver, respectively. The number of plan deviations is measured as the number of en-route diversions a given driver experiences in execution (i.e. the number of times that a driver receives instructions to carry an alternate load, after he is already in the process of driving to a previously specified order). This metric is normalized by the total number of orders that the driver receives over the full horizon of execution. The geographic range of a driver is measured by examining the list of zip codes visited by a given driver as compared to the list of zip codes the driver prefers to visit – as such, this measure can range from 1 (indicating a 100% match between the two lists) to 0 (indicating a 0% match). Graphical depictions of the membership functions for these two measures may be seen in Figures 4 and 5.

**Figure 3** Graphical depiction of driver idle time membership functions

**Figure 4** Graphical depiction of en route diversion membership functions.

**Figure 5** Graphical depiction of driver geographic range membership functions.
Moving from these three fuzzified driver satisfaction measures, encompassing a total of eight functions, to a representation of driver satisfaction requires the definition of connectives. Connectives are rules indicating the functional form of the output set or sets; defined as subset(s) of the full output space, for driver satisfaction. The definition of these connectives is the focus of Step 3b.

**Step 3b) Defining connectives to combine measures via rules**

Within this example the eight functions spread across the three KPIs are combined in such a way that two subsets of the output space emerge – these represent the linguistic terms “happy" and “unhappy”. It is these measures of happiness that are then translated (in Step 3c) to a single score of satisfaction. Developing the rules to map the functions of Step 3a to the sets “happy" and “unhappy" is not a precise science. In practice, these rules should be derived by asking a pool of drivers which KPI influences their happiness the most or which interaction of KPIs produces a happy or unhappy result. In this case, however, we developed the rules using common sense alone.

The rules we constructed are as follows:

1. If (idle time is good AND deviations is good AND geographic range is good) OR (idle time is ok AND deviations is bad AND geographic range is good) OR (deviations is ok AND geographic range is good) then the driver is happy.
2. If (idle time is bad OR deviations is bad OR geographic range is bad) OR (deviations is ok AND geographic range is bad) then the driver is unhappy.

Mathematically, these rules become:

1) Happy := max{min{\(D_{1,g}(x), D_{2,g}(x), D_{3,g}(x)\)}, min{\(D_{1,o}(x), D_{2,b}(x), D_{3,g}(x)\)}, min{\(D_{2,o}(x), D_{3,b}(x)\)}}
2) Unhappy := max{max{\(D_{1,b}(x), D_{2,b}(x), D_{3,b}(x)\)}, min{\(D_{2,o}(x), D_{3,b}(x)\)}}

In this way we can map the driver experience with the designated KPIs into two sets describing a level of happiness with the system’s performance. The next step addresses how we convert emerging levels of happiness/unhappiness into a single score of satisfaction.

**Step 3c) Choosing a defuzzification procedure**

We are now at the point where the overall fuzzy output must be summarized in a single value. In this case, that single value represents driver satis-
faction. The defuzzification procedure that we apply for all stakeholder groups is called center-of-area.

In this case two fuzzy variables are to be defuzzified to derive the driver satisfaction measure - Happy and Unhappy. As a result of the rules defined in the previous step Happy and Unhappy will have values in \([0, 1]\) expressing the happiness and unhappiness of the driver simultaneously. Since happiness and unhappiness are the two extremes of the satisfaction spectrum we chose to define them as in Figure 6.

![Figure 6](image_url) Illustration of “defuzzification” procedure.

Here, Happy is defined by the triangle on the points, \((0, 0), (10, 1),\) and \((20, 0)\) at the upper end of the satisfaction spectrum (around the value 10). Unhappy, defined by the points \((-10, 0), (0, 1), (10, 0)\) is at the lower end (around the satisfaction value 0). The center-of-area defuzzification method works as follows. First the triangles representing the fuzzy values are discounted (in height) proportional to the actual values of Happy and Unhappy, in this example, 0.85 and 0.2, respectively. The point that divides the combined area of the two discounted triangles equally is returned as the result; in this example, \(~3.7\). Note that the satisfaction value will always be between 0 and 10. In the event that either Happiness or Unhappiness is zero, the satisfaction score will be either 0 or 10 respectively - regardless of the value of the other variable.

The fuzzy rules within this vehicle routing case are always defined (see APPENDIX A) to result in two fuzzy sets expressing the happiness and unhappiness of the stakeholder groups. In this regard, the same method of defuzzification is always applicable to derive the satisfaction scores of all three stakeholder groups.

**4.2.4 Step 4: Application of Evaluation Framework**
As noted in Section 4.1, the decision support systems this evaluation framework is aimed to judge are three different (and competing) agent-based planning systems designed and prototyped for the specific case of container transport at Post-Kogeko. The Free University Amsterdam works on a system that uses an advanced market place architecture to negotiate deals between the transportation company and its customers. Almende and the TU Delft work on a flexible planning system, where trucks and containers negotiate contracts that can be changed in case future events make this necessary/beneficial. RSM Erasmus University works on a system that focuses on real-time assignment – which means a focus on operational real-time control in a dynamic environment instead of planning beforehand, and re-arranging when events occur. The application of our proposed evaluation framework to these three systems allows for a fair comparison of the systems while also permitting the identification of their strengths and weaknesses.

The output of each of the three systems when run in simulation is a routing plan and a record of execution (that is a record detailing how the plan was actually carried out once implemented). An overview of how these output items are used in the evaluation framework is presented in Figure 7. These two items serve as the basis for the derivation of the ten KPIs identified in Section 4.2.2. Once each of these ten metrics is derived they are fed into the fuzzy model (as described in Section 4.2.3). Note, the fuzzy model depends on a set of customer, driver, and society preferences stored external to the simulator. In this study, we define preferences at the group level, that is each individual member of a stakeholder group has the same set of preferences. Key to this application of the evaluation framework is that the management KPIs are not translated into a measure of satisfaction. This decision was made as management is usually concerned with viewing the hard metrics as an indicator of profit and performance. There is thus little reason to fuzzify the metrics before including them in the final score.

Once the satisfaction scores have been obtained and defuzzified, they must be combined with the management score (an aggregation of hard metrics) to obtain a total score for the system. We recommend the use of a linear function to combine the management and stakeholder satisfaction scores such that each score is weighted by a term, $\alpha$, denoting the relative importance of each stakeholder group’s satisfaction in the eyes of management. We recommend that the weights be derived via organized focus groups with management.
Figure 7 Application of the evaluation framework to the vehicle routing decision support system simulation output.
In this paper we propose a framework for the evaluation of networked business performance that includes both soft and hard measures. In our experiments we use this framework to evaluate the performance of competing software prototypes for logistical planning. Based on planning and execution data the evaluation framework derives scores for the soft measures by fuzzifying certain measured values, applying fuzzy rules that are defined based on expert knowledge, and finally defuzzifying the happiness/unhappiness fuzzy sets. The strength of the framework is that it formalizes the underlying business logic in a human-readable way; in fact humans are primary sources in defining the right measures and rules. The next section discusses future directions for continuing this line of research.

5. Discussion

This paper demonstrates the potential for a generalized evaluation framework to be tailored and applied to the problem of measuring the performance of disparate decision support systems in a freight logistics environment. The evaluation framework is unique in that it incorporates, via fuzzy logic, measures of employee, customer, and society satisfaction. The implications for this evaluation framework are significant.

Besides the use of this framework as a pure evaluation tool, we expect its usefulness also to lie in the decision support domain. A decision support tool integrated with a tailored evaluation framework will be able to suggest decisions and plans optimized on an acceptable balance of hard metrics and satisfaction scores calculated on the basis of domain knowledge gained from long-term relations with other organizations in the business network. Additionally such a system can explain these recommended decisions using human-readable rules. For example, a low satisfaction score can be easily understood and addressed by examining the hard metrics alongside the fuzzy rules used to generate the satisfaction score. In this way a business strategy can be developed to address the specific metrics most significantly influencing the satisfaction score; thereby ensuring long term customer, employee, and society satisfaction.

Setting and maintaining the rules and fuzzy membership functions is an important but tedious task. However, we expect that this task may benefit greatly from automated learning techniques. Automated learning from past performance brings up several interesting research questions: Can we utilize (automated) performance evaluation methods to gather domain knowledge which feeds back into the (automated) decision making process? How to divide and handle the different layers of abstraction? When do new
Given the potential of this research, we would like to further investigate mechanisms by which to extract and model domain knowledge from experts in the logistics industry. In this paper we use fuzzy logic, but we remain open to other models. Additionally, we are interested in deriving a more realistic image of human reasoning and satisfaction from performance history data within a networked enterprise, using concepts known from the data mining and business intelligence fields.

Developments in economies around the globe impact enterprises and organizational structures in many different ways. The role of modern information and communication technologies is important in this context having a vast impact on organizational processes. Competition becomes a 24/7 business, requiring real-time decision support systems. In parallel, companies increasingly operate in (supply) chains or business networks, requiring inter-organizational enterprise systems instead of traditional single-company focused systems. Performance evaluation and management, of individual companies and networks thus becomes a crucial topic; surprisingly, existing research in this domain is still limited. The world around us is colored by perceptions and conceptions and may not be summed up by hard metrics alone. We therefore struggle with "measuring the unmeasurable", which is likely to culminate into "controlling the uncontrollable" – a major challenge, and an interesting domain for future research.
References


### APPENDIX A

<table>
<thead>
<tr>
<th>KPI</th>
<th>Normalized</th>
<th>Fuzzy Set Functions</th>
<th>Fuzzy Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty distance traveled</td>
<td>Empty distance traveled/total miles traveled</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Profit per delivery</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Profit per kilometer</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
| Driver idle time            | Driver idle time/Total driver on-duty time | \[ D_{1b}(x) = \begin{cases} 
0 & \text{if } x \leq 0.5 \\
2x & \text{if } 0 < x \leq 0.5 \\
2x & \text{if } 0 < x \leq 1 \\
1 - 2x & \text{if } 0 < x \leq 1 \\
0 & \text{if } x > 1 
\end{cases} \] | If (Driver idle time good and on route diversions good and geographic range good) or (Driver idle time ok and diversions bad and geographic range bad) then driver is happy |
| Number of plan deviations   | En route diversions/total orders served | \[ D_{2b}(x) = \begin{cases} 
1 - 2x & \text{if } 0 < x \leq 0.5 \\
2x & \text{if } 0 < x \leq 1 \\
0 & \text{if } x > 1 
\end{cases} \] | If (Driver idle time bad or diversions bad or geographic range bad) or (Driver idle time ok and geographic range good) then driver is unhappy. |
<p>| Geographic range of driver   | % of zipcodes visited in execution matching the driver’s preferred list of zipcodes | [ D_{3b}(x) = x \quad \text{or} \quad D_{3b}(x) = -x ] |            |</p>
<table>
<thead>
<tr>
<th>KPI</th>
<th>Normalised</th>
<th>Fuzzy Set Functions</th>
<th>Fuzzy Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule deviation¹</td>
<td>Number of orders in the maximum span of consecutively on-time orders / Total number of orders</td>
<td>$C_{1,4}(x) = x$</td>
<td>if (number orders in max on-time span good or [number of early orders good and number of orders in max span early good] or total minutes attributable to max early good) and (number of orders in max span on-time good or [number of late orders good and number of orders in max span of late good] or total minutes attributable to max late good) and drivers serving good and job rejected good then customer is happy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$C_{1,4}(x) = 1 - x$</td>
<td></td>
</tr>
</tbody>
</table>

¹ Minutes of schedule deviation is split into two categories spanning 4 metrics each, in order to better capture how customers judge their satisfaction based on order delay (or tardiness). Notice, in the expanded measures a customer’s perception of satisfaction may be based on a period of time in which many orders were late or many orders were on-time.
<table>
<thead>
<tr>
<th>KPI</th>
<th>Normalized</th>
<th>Fuzzy Set Functions</th>
<th>Fuzzy Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td>Number of early orders/Total number of orders</td>
<td>$C_{l_1}(x) = 1 - x$</td>
<td>$C_{l_1}(x) = x$</td>
</tr>
<tr>
<td>Early</td>
<td>Number of orders in the maximum span of consecutively early orders/Total number of orders</td>
<td>$C_{l_2}(x) = 1 - x$</td>
<td>$C_{l_2}(x) = x$</td>
</tr>
<tr>
<td>Late</td>
<td>Total minutes of earliness attributable to the maximum span of consecutively early orders/Total minutes of earliness for full execution</td>
<td>$C_{l_3}(x) = x$</td>
<td>$C_{l_3}(x) = 1 - x$</td>
</tr>
<tr>
<td>Late</td>
<td>Number of late orders/Total number of orders</td>
<td>$C_{l_4}(x) = 1 - x$</td>
<td>$C_{l_4}(x) = x$</td>
</tr>
<tr>
<td>Late</td>
<td>Number of orders in the maximum span of consecutively late orders/Total number of orders</td>
<td>$C_{l_5}(x) = 1 - x$</td>
<td>$C_{l_5}(x) = x$</td>
</tr>
<tr>
<td>Late</td>
<td>Total minutes of lateness attributable to the maximum span of consecutively late orders/Total minutes of earliness for full execution</td>
<td>$C_{l_6}(x) = x$</td>
<td>$C_{l_6}(x) = 1 - x$</td>
</tr>
<tr>
<td>KPI</td>
<td>Normalized</td>
<td>Fuzzy Set Functions</td>
<td>Fuzzy Rules</td>
</tr>
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<td>------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Driven serving each customer            | % of drivers visiting a customer in execution matching the customer’s preferred list of drivers | $C_{D}(x) = 1 - x$  
$C_{L}(x) = x$                                                           |                                                                            |
| Number of jobs rejected                  | Number of jobs rejected: Total number of orders                             | $C_{D}(x) = 1 - x$  
$C_{L}(x) = x$                                                           |                                                                            |
| Capacity utilization                     | Number of trucks used total number of trucks available                      | $S_{G}(x) = \begin{cases} 1 & 0 < x \leq 5.5 \\ 2x - 1 & 5 < x \leq 10 \end{cases}$  
$S_{L}(x) = \begin{cases} 0 & 0 < x \leq 5 \\ 2 - 2x & 5 < x \leq 10 \end{cases}$ | If Capacity utilization is good then society is happy.  
If Capacity utilization is bad then society is unhappy. |

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Abstract

The external buying of IT resources and services is an increasingly common activity for most firms. Whereas previous work focused at the firm level or the buyer-supplier dyad, the present study focuses on the configuration of exchange relationship portfolios between buyers and suppliers. We investigate these portfolios at an online marketplace for IT services. We draw on the social network theory to measure portfolios as buyer’s ego networks. Using K-means clustering, we empirically derive a taxonomy of portfolios of SMEs buying IT services and interpret their networking behavior.

Our investigation reveals five distinct clusters of buyers’ ego networks (transactional buyers, small buyers, diversifiers and relational (large) and relational (small) buyers), each of which has a distinct and different mix of long-term relationships with selected suppliers and short-term transactional relationships. Reverse auctions are found to be associated with a short-term exchange relationship orientation, while bilateral negotiations support long-term orientation. Buyers in different clusters use the two exchange mechanisms in combination to a different extent.

Keywords Online Markets, Reverse Auctions, IT outsourcing, Empirical Taxonomy
1. Introduction

The recent rise of online marketplaces for professional services (e.g. Elance Online, Rent a Coder and eWork) improves the access of firms to offshore suppliers of outsourcing services. IT services, such as website design and software development, are a primarily focus for these marketplaces.

Marketplaces for IT services provide a valuable ground for studying a number of exchange-related issues of high theoretical and practical importance. Recent studies addressed bidding and buying behavior under costly bidding and bid evaluation (Snir et al. 2003); market participation costs (Snir et al. 2004) and buyer’s commitment and opportunism (Radkevitch et al. 2005b). This study is focused at two main themes that emerge in light of the increasing use of online IT marketplaces by firms: the development of long-term as opposed to short term relationships between buyer and supplier and the underlying use of exchange mechanisms (open reverse auctions vs bilateral negotiations) for transactions.

This study takes an exploratory approach. We aim at deriving taxonomy of repeat buyers of IT services on the basis of the buyers’ relationships orientation and exchange mechanism use. Ego networks, or portfolios of exchange relationships, have been chosen as a unit of analysis. This allows us to focus on a combination of buyer-supplier relationships and exchange mechanism use in deriving the taxonomy of buyers. The main research question this study intends to answer is this: What types of buyer ego networks are formed at online IT marketplaces?

From the theoretical perspective, the study contributes to understanding different types of buyers of IT services. From the managerial perspective, we provide insights into how online markets for IT services, while traditionally aimed at enabling short-term efficiencies, could also serve exchange relationships that rely on long-term considerations.

The remainder of the paper is organized as follows. First, we make the case for the choice of an exploratory approach for the study. Next, we discuss theoretical roots of the dimensions of the taxonomy. This is followed by a discussion of the methodology, data and analytical procedures. Finally, we discuss the findings and formulate theoretical and managerial contributions.
2. Development of a buyer taxonomy

The literature tradition in both inter-organizational relationships and information systems hosts confirmatory and exploratory approaches to empirical research. Confirmatory approaches take a taxonomy deduced from extant literature and test for the occurrence of pre-defined constructs and types, whereas exploratory approaches derive the taxonomy inductively from the data and then relate them back to theory. While traditionally the confirmatory approach has tended to dominate, exploratory approaches have been used effectively as well, particularly in situations where existing theory was deemed insufficiently detailed to do justice to the richness of the field setting. In the area of inter-organizational relationships the exploratory approach has been used to extract and analyze patterns of inter-organizational relationships, sometimes also relating them to antecedents and performance characteristics (Bensaou et al. 1995; Cannon et al. 1999). Along the same lines, in the information systems literature the exploratory approach has been used for instance to develop a taxonomy of eBay buyers and relate resulting buyer types to winning likelihood and extracted surplus (Bapna et al, 2004). Given these examples that are closely related to our topic, as well as the newness and richness of our setting of online marketplaces for IT services, an exploratory approach seems sensible at this point.

As we are interested in exploring empirical configurations of buyers’ relational orientation and their use of exchange mechanisms, we chose to focus on a buyer’s ego network as a unit of analysis. The concept of ego network in social network analysis resonates with the concept of “portfolio of relationships” in the marketing literature. For instance, (Bensaou 1999) used this concept in his study of the relationships between manufacturing companies in automotive industry and their suppliers. Similarly, by using ego networks or portfolios of relationships in the present study, we are able to capture the key dimensions of interest in the taxonomy development as structural or compositional properties of ego networks. In the remainder of the paper we are using both terms (buyer ego networks and portfolios of relationships) interchangeably.
**Taxonomy Dimensions**

*Inter-organizational relationships*

The two polar modes of organizing interorganizational exchange relationships are transactional and relational exchange. Transactional exchange is characterized by short-term, arm’s-length transactions, where parties have a competitive attitude toward each other (Dyer et al. 1998). While in transactional exchange firms exploit market efficiencies to derive one-time profit, in the relational exchange firms are seeking “relational rent” (Dyer et al. 1998) over a longer period of time and/or over a series of transactions (Ganesan 1994). Parties to relational exchange rely on relational attributes, such as trust, commitment, collaboration, information sharing, etc (Dyer et al. 1998; Ganesan 1994) to create value.

While in the literature on interorganizational relationships (e.g. relational exchange theory or the embeddedness perspective) a lot of efforts have been invested into the research on the stages and processes of relationships development (Dwyer et al. 1987; Ring et al. 1994) and interplay between transactional and relational elements of exchange (Daly et al. 2005), relatively little has been said on the role and development of relationships in situations with characteristics of both transactional and relational exchange, even though such situations are intuitively quite plausible. These can be, for example, IT projects, such as software development, where parties often have to jointly work on system requirements, develop functional specifications, maintain communications during the project run and jointly deploy and test the final deliverables. Although the project-based nature makes them comparatively transactional, the activities that need to be performed within the project also require certain relational elements to be in place, thus creating a mixture of transactional and relational elements that is insufficiently theorized in extant literature (but see Lambe, Spekman & Hunt (2000) for an initial step in this direction). Thus our first dimension used in developing the taxonomy is the relational orientation (short vs long-term) of repeat buyers.

*Reverse auctions*

An auction is defined as “a market institution with an explicit set of rules determining resource allocation and prices on the basis of bids from participants” (McAfee et al. 1987). In reverse auctions suppliers compete online for a contract to supply goods or services to the buyer and the prices go down. There is uncertainty and competing claims with regard to the use of reverse auctions and their effects on buyer-supplier relationships in the extant literature. On one hand, reverse auctions stimulate competition
among suppliers (Jap 2003) and make them concerned about buyer’s opportunistic behavior (Jap 2003). On the other hand, reverse auctions are compatible with several dimensions of relational exchange, as reverse auctions can be used to source long-term contracts, can co-exist with a high level of trust (Radkevitch et al. 2005a) and collaborative buyer-supplier relationships (Smart et al. 2003). In addition, in real-life situations, bidder and buyer behavior is influenced by a variety of factors that are not covered in existing auction theory (Jap, 2002). Therefore, the extent of the use of reverse auctions by repeat buyers is the second dimension of our taxonomy.

Transaction characteristics

Transactions cost economics regards transaction characteristics as a determinant of exchange governance (Williamson 1985). High level of transaction attributes such as frequency of transactions, asset specificity and technological uncertainty calls for hierarchical exchange governance to minimize the transaction costs. While hierarchies are efficient in keeping down costs of coordinating complex transactions, market governance is advantageous when transactions are less complex and exchange efficiency is achieved due to low costs of production (Williamson 1985). In a similar fashion, transaction attributes become important when the choice is about the market exchange mechanism. For instance, more complex construction projects, where ex-post negotiations are likely, are found to be more appropriate for negotiations, while less complex contracts with no ex-post negotiations fit well competitive bidding (Bajari et al. 2001). Therefore, our third dimension consists of the characteristics of the IT projects, particularly those related to the complexity of the project.

3. Methodology

Empirical setting

We used transaction data from a leading online marketplace for professional services for small businesses, used by around 60,000 buyers. Established in 1998, the online marketplace contains around one thousand simultaneously active projects across all service categories and data on tens of thousands of auctions completed to date. By early 2006 the overall value of transactions facilitated by the marketplace exceeded USD 90 million. The range of services encompasses IT services and other professional services (e.g. translation, accounting, etc). Software application development is one of the most populated areas of the marketplace. Buyers are businesses and individuals coming predominantly from the US, while sup-
pliers are small/medium IT outsourcing companies and freelancers located in India, Eastern Europe and Russia. Some of the most active suppliers have turnover over USD 100,000 in accomplished projects over the recent six months and over USD one million over the time of their presence at the marketplace.

The exchange process is organized as follows. Before buyers and suppliers are able to enter the exchange they are required to register at the marketplace. Participation for buyers is free of charge while a periodical fee applies to suppliers (suppliers also pay a commission on all accomplished transaction). The buyer starts an auction by posting a request for proposals (RFP). The allocation mechanism comes in two basic types: open auctions (all suppliers can bid) and invite-only auctions (only invited suppliers can bid). In 95% of cases where an invite-only auction is held, there is only one supplier invited, therefore we consider invite-only auctions to be bilateral one-on-one negotiations rather than auctions from a theoretical standpoint. Upon selection of one (or several) winner, the parties can further clarify the details and scope of the project.

After the project is finished, the buyer is able to rate the supplier’s performance. The accumulated supplier’s rating is a part of the reputation and trust mechanism at the marketplace.

Data
We collected data on buyer’s ego networks on the basis of buyers’ activity at the most populated sub-marketplace, Website Development. There were several stages in data collection and data processing. First, we focused on repeat buyers with a considerable exchange track record at the marketplace to ensure that each buyer had done enough projects to ensure a reasonable portfolio. We identified the most active buyers using a cut-off level of 20 awarded projects over the total time period that buyer was active. This resulted in a sample of 530 buyers that awarded 20 to 300 projects each. Second, each of the projects needed to have the necessary project data available on the website. Since the required data are only available for finished projects where feedback on the supplier’s performance is submitted, we checked for the percentage of projects available for analysis in each ego network by dividing the number of projects reported in the feedback section by the overall number of buyer’s projects. In case feedback on at least 70% of buyer’s projects was available (which is the cut-off level we chose to ensure a reasonable amount of data in an ego network), the ego network was included in the further analysis.

The described procedure resulted in 105 ego networks suitable for cluster analysis. They contained data on 2,193 projects worth a total of USD
1,135,041. Two ego networks were later deleted from the analysis because of the missing critical variables or extreme values.

The data in the dataset were standardized in order to avoid disproportional impact of nominally higher variables in the cluster analysis. The descriptive statistics of standardized coefficients (z-scores) is presented in Table 1.

Analysis

Cluster analysis consists of two stages – identification of the number of clusters and clustering observations in the sample. While there is normally little uncertainty with regard to the second stage, the first one can be realized in a variety of ways. In the present study we chose to apply rather simple and elegant solution suggested by (Bapna et al., 2004).

First, we applied K-means clustering method to find a number of different cluster solutions for our dataset. The K-means clustering method is normally used at the confirmatory stage of cluster analysis, when the number of clusters is exogenously known or has been established by preceding analysis (McQueen, 1967). The method clusters objects into k partitions based on their attributes. The method assumes that the attributes form a vector space and aims to minimize total within-cluster variance. It is commonly used in the IS and marketing studies as a part of the procedure to established typologies of actors, e.g. bidders (Bapna et al., 2004) or buyers (Bensaou and Venkatraman, 1994; Cannon and Perreault, 1996).

Second, as advised by (Bapna et al., 2004), for each cluster solution we calculated average distance from points in a cluster to the relevant cluster center (intra-cluster distance) and minimum distance between cluster centers among all clusters (intercluster distance). Better cluster solutions have smaller intra-cluster distances (the clusters are more homogeneous) and larger intercluster distances (the clusters are situated more apart from each other). Then, we establish the optimal solution by dividing intercluster difference of a cluster by intra-cluster difference of the same cluster, which is dissimilarity ratio (Bapna et al., 2004), and comparing them. The optimal cluster should have the highest dissimilarity ratio. According to the results in table 2, in our case the optimal solution is the one with five clusters.

Table 3 summarizes the variables that operationalize our three taxonomy dimensions: relationship characteristics, type of exchange mechanism used and transaction characteristics. The variables are: share of open auctions in the ego network (as an indicator of the exchange mechanism used); monetary size of the ego network (USD), average project price (USD) and average project length (days) as indicators of project complex-
ity (larger projects, both time wise and financially, being deemed more complex), and share of projects per supplier with the highest number of projects in a given ego network and duration of relationships with the most used supplier (days), both as indicators of the relational orientation of the buyer (with higher values on either variable indicating a more relational orientation ceteris paribus). The descriptive statistics is presented in table 4.

The results of the ANOVA procedure on the cluster centers (centroids) in table 4 show that the differences between centroids for all six variables are significant at p<0.001 level. Although some of these cluster sizes are small, the average values for the different dimensions show that they are indeed substantively different types, thus justifying their inclusion as a separate cluster. The 5-cluster solution results in groups of 11, 45, 5, 35 and 9 ego networks. The average values of the variables underlying the three cluster dimensions are presented per cluster in table 5.

Based on the characteristics of ego networks in the clusters we came up with the following labels for the buyers in these clusters: Small buyers, Transactional buyers, Relational (large) buyers, Relational (small) buyers and Diversifiers. As follows from the labels, the buyers in these clusters exhibit different approaches to the exchange relationships with the suppliers.

Cluster 1. Small buyers. This group of buyers is remarkable by the extreme duration of their projects (115 days), which is almost twice as long as the second longest projects of Relational (large) buyers (68 days), although the latter are over three times larger. We suggest that such a long project duration can be a result of the small size of these buyers and/or their suppliers (e.g. they can be one-man businesses) that could limit their task processing and coordination capabilities, thus resulting in longer time to complete projects. Another possible explanation is that the projects are more long-term maintenance contracts that are outsourced, rather than one-off development contracts. Therefore, this cluster label “Small buyers” should be regarded as iterative until evidence supporting these or other explanations emerges in further research.

Cluster 2. Transactional buyers. Most projects in ego networks of this type are procured via open reverse auctions (71%). The projects are also the cheapest among all clusters (USD 388). These buyers allocate few projects with a single preferred supplier, 32%, which is the lowest level among all clusters. Duration of relationships with the preferred (most often used) supplier is also the shortest of all, 257 days. It is clear that in comparison with all other buyer types, these buyers prefer not to enter in stable relationships with suppliers and rely on competitive project allocation. This is probably due to the re-negotiations with and the need for mutual
adjustments to the new suppliers that their projects take considerably longer to accomplish (46 days) than more expensive projects of Relational (small) buyers (28 days).

Cluster 3. Relational (large) buyers. These buyers use open reverse auctions rarely (18% of projects); by contrast, in 82% of projects they use negotiations, i.e. invite-only auctions. Their portfolio size (USD 38,044) is the largest among all buyers and so is the average project value (USD 1,813). These buyers allocate three quarters of their projects to a single preferred supplier (75%). The duration of relationships with the preferred supplier is the longest of all clusters (1,016 days).

Cluster 4. Relational (small) buyers. With respect to the use of auctions and working with the referred supplier, these buyers are very similar to the buyers in the previous cluster, although perhaps in a more pronounced way. Buyers of this type use open reverse auctions least often (16%) and rely on preferred suppliers more than buyers of any other type (80% of projects). Their major difference from the buyers in the Relational (large) buyers cluster is the size of project portfolio and average project size. This is most probably the higher complexity of projects that explains why projects of Relational (large) buyers tend to take over twice the time of those of Relational (small) buyers.

Cluster 5. Diversifiers. Most of the projects of these ego networks are allocated through negotiations (69%). These buyers conduct more transactions than others, and these transactions are of higher value than transactions of the other buyers, except Relational (large) buyers. One similarity with the Transactional buyers is that diversifiers do not allocate many projects with one preferred supplier (only 42%). Instead, they might be using several suppliers on a long term basis, either in parallel or sequentially. Hence the choice of the name for this cluster – “diversifiers”.

4. Conclusions

There are several key findings in the present study. First, and in contrast to most of the extant literature that tends to use a simple continuum from transactional to relational buyers, our exploratory approach revealed the existence of five clusters of repeat buyers at the marketplace – small buyers, transactional buyers, relational (small) buyers, relational (large) buyers and diversifiers. These labels were derived on the basis of buyer’s preferred mode of relationships with the suppliers and indicate substantively different rationales for managing a portfolio of relationships. While transactional buyers tend to switch suppliers often, relational buyers (both the small and large buyers) tend to develop long-term persistent dyads with se-
lected suppliers. Diversifiers seek a mix of the two approaches, whereas the small buyers have a different approach again. The existence of a relatively large cluster of buyers that rely on long-term relationships with the suppliers comes a bit as a surprise, as the marketplace positioning and functionality emphasizes a competitive, transactional way of procuring IT services.

It is not clear from these results, however, to what extent the emergence of long-term buyer-supplier relationships is due to mere economic efficiency (staying with a one supplier saves switching costs) and to what extent it can be explained by the development of interorganizational relationships, such as trust, cooperativeness, mutuality, etc. This will be a focus of our subsequent research.

Second, reverse auctions are found to be associated with a short-term relationship orientation, while bilateral negotiations support a long-term orientation. However, even relational buyers use open reverse auctions to a certain extent. This is a sign that different exchange mechanisms can be used interchangeably at different stages of the development of supplier portfolios. At first, a buyer selects one or several sequential projects via the competitive open auction procedure. At a later stage, when the supplier’s quality has been proven and longer-term relationships start to emerge, the buyer switches to a non-competitive bilateral negotiation procedure. Therefore, while transactional buyers use reverse auctions for an optimal project allocation on the basis of the price, supplier’s reputation, project proposal as well as actual and reported experience, relational buyers use reverse auctions as a screening instrument. Once the trust in a supplier has been established, reverse auctions are substituted with bilateral negotiation for further projects.

Third, this study also has important implications for practice. We showed that long-term cooperative relationships do develop between at competitive marketplaces for IT services. As the reliance on relational elements in a bilateral exchange is growing, the need for the mechanisms of formal governance (e.g. formal terms and conditions, arbitration, rating systems) decreases and the parties become less dependent on the marketplace for further transactions. As the costs of carrying out exchange via online marketplace exceed the benefits, the established buyer-supplier dyads may leave the marketplace and embark on off-market exchange. To prevent buyer-supplier dyads from leaving, online marketplaces need to cater for “relational” exchange as well. This must address key characteristics of such exchange, such as it long-term nature; intensive information
exchange and re-use of accumulated knowledge. In other words, the online marketplaces for IT services need to provide a collaboration platform for relational exchanges.

References


Report Parallel Session C

Reporter: Jordan Srour

In this Friday morning session, three presentations were given; each roughly themed around the exploration of mechanisms by which to capture the intrinsic (structure and performance) and extrinsic (operating environment) properties of a business network. These properties may have implications for overall network viability and longevity – this was the primary topic of discussions following each presentation.

The first presentation given by Wolfgang Ketter focused on methods by which the sales environment and transitions between environments (as defined by regimes such as over supply or scarcity) may be deduced from historical data and information garnered from a local perspective within a network of suppliers, buyers, and other agents. The method of deducing environmental conditions was based on a Gaussian Mixture Model representing the price density in addition to a Markov process to predict price density and forecast market changes. The presentation was supported by experimental results garnered from participation in the Trading Agent Competition for Supply Chain Management. Discussion following this presentation focused on how the behavior of others may influence market conditions and how this behavior might be captured within the methods for sales environment prediction. There was also some discussion regarding the value of additional information in improving predictive capabilities – would information gained through agent collaboration yield improvements in prediction significant enough to support such collaboration?

The second presentation, given by Jordan Srour, examined mechanisms by which a firm’s performance may be evaluated within the context of the network in which it operates. Aside from the traditional objectives that can be measured quite precisely, in a networked enterprise there are also short and long-term customer and supplier relations to be considered. As presented, these factors are often much harder to measure and compare. Fuzzy logic is the mechanism suggested for capturing these projected or surmised gauges for the satisfaction of network partners. The overall performance evaluation approach was illustrated with an example from freight logistics. The focus of the discussion following the presentation was primarily centered on the choice of fuzzy logic to capture the satisfaction levels of entities in the network. Additional topics of discussion focused on the differ-
ences between evaluating network performance, evaluating a company’s performance within a network, and evaluating performance of a decision support system applied to a company in a network.

The third and final presentation of the session, given by Uladzimir Radkevitch, described the structure of a buyer’s ego network (a portfolio of exchange relationships) dependent on observed IT procurement behavior within an online market place. The study specifically focused on interpreting the networking behavior of small and medium enterprises buying IT services. As depicted in the presentation five distinct clusters of buyers’ ego networks emerged, each with a distinct mix of long-term supplier relationships and short-term transactional relationships. An interesting result included in this research is how the structure of the auction itself can promote specific network patterns or exchange relationships. For example, reverse auctions are found to be associated with a short-term exchange relationship orientation, while bilateral negotiations support long-term orientation. This last result was the primary focus of the ensuing discussions – what format of auction promotes the mix of exchanges most beneficial for the longevity of the marketplace itself?

The overall message encapsulated in this session was the need for more research to apply meaning to the derived intrinsic (structure and performance) and extrinsic (operating environment) network properties. What do these properties imply for the viability of a business entity in a given network and the viability of the network within a variety of environments? For example, does the capability of predicting sales environments, as presented in Wolfgang Ketter’s work, promote or hinder the growth and longevity of a buyer and seller network? What do the performance measures emerging from the evaluation framework presented by Jordan Srour really indicate about a company’s survivability in a networked environment? How can knowing the influence of auction and marketplace structure on buyer and seller exchanges, as presented by Uladzimir Radkevitch, be exploited to promote long term business relations?
20. Designing and Implementing Contracts for Smart Business Networks

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1. Introduction

The idea of a Smart Business Network (SBN) has come up only recently and it can therefore not be assumed that general knowledge of this concept is wide-spread among the information systems community. In such a situation it is good scientific practice to explore possible definitions of the central term. We start with giving a verbatim account of a definition that we found to be the most operational one, i.e. the one that discloses rich details about the nature of a SBN. According to this definition an SBN is

- “A group of participating businesses – organisational entities or “actors” – that form the nodes, and this group is not necessarily visible to the outside;
- Linked together via one or more communication networks forming the links, or lines, between the nodes;
- Linked together as well by a set, possibly ontology-based, of bilateral or SBN network wide, agreements or service level agreements (SLAs) of a temporary nature;
- Interacting in novel ways they could not implement on their own, or possibly with other parties; this is the SBN network benefit;
- Perceived by each participant as increasing his own value, meaning that while overall goals/utility functions may be different, some can be shared within the network with estimated derived positive benefits; the basic equilibrium concept is one of a non-cooperative Nash game, and not of a collaborative Pareto game;
- Sustainable over some time as a network, subject to agreed upon termination rules;
- Resilient if one or more businesses, nodes in the network, drop out, disappear, or malfunction.” [21]
Here we will primarily focus on the third aspect of this definition, i.e. the link between the network actors in the form of bilateral or network-wide agreements (contracts). Before we go on with that let us first summarize very briefly the work presented in [21]. According to this the smartness of a SBN can be achieved by moving some of the business logic concerning cooperation of actors into the communication network. Here we take a slightly different stance by distinguishing between two networks:

a) the business network, which is a social network involving communication between human actors that might represent, i.e. act on behalf of, some organization or other, or they might also act on their own (e.g. as individual, private customers);

b) and the communication network, which is a technical network that provides the infrastructure for the business network.

Our goal is to support the set-up and operation of a SBN. The first phase consists mainly of the design of a contract that can be used to coordinate the behavior of network actors. The design process is cooperative, i.e. the actors negotiate this contract among themselves. Such negotiations can be either bilateral or multilateral but both types will contribute to creating one common contract that is binding for all parties involved. We also call this negotiation process a co-design process. Negotiation is a social process that proceeds on the business network layer but it can be supported by a negotiation support system that makes use of the communication network. This eliminates the need for partners to meet face to face and contributes to a flexible set-up of the SBN. It implies that the lead-times for setting up the network are relatively short and replacing members that have left and adding new ones can be done with a minimum of effort. These are crucial issues for a SBN.

The second phase, operation, consists of implementing the behavior specified in the contract. Here the business logic concerning the coordination of actors is incorporated into the communication network. In this this we phase “translates” from the business network to the communication network by managing the respective message exchange via the technical network and a coordination server.

We have used this approach to transform an existent “conventional network” into a SBN that consisted of three partners: the headquarters of a retail chain in the home textile and home decoration industry, the shops of this chain and a third-party logistics provider. Although this is a minimal case of a SBN it nevertheless provides fundamental insights into the workings of such networks.

The remaining chapters are structured as follows. We first address the issue of coordination in organizational networks in general and SBNs in particular, which leads us to the identification of a suitable class of con-
tracts, namely behavior-based contracts. The next sections study the nego-
tiation process and a language for formulating behavioral contracts. We
then proceed by describing the implementation of the formalized contract
based on a communication network and a coordination server. We con-
clude this paper by summarizing the major findings and presenting an out-
look on future research.

2. Coordination in a SBN

In a Smart Business Network organizations strive for the provision of
complex products and services by coordinating their activities in an “intel-
ligent” way. This implies that the coordination effort is much higher than
in a conventional supply chain. In the latter an individual company can fo-
cus on managing the relation to a few immediate major suppliers for creat-
ing a product or service. In an SBN this is not enough but coordination is
also required among the suppliers. Theoretically we move from a tree
structure to a graph topology which implies that we have to hit a new bal-
ance between market and hierarchical coordination.

The general problem behind this is quite old and several theories have
been advanced to explain the use of a particular form of coordination, most
notably Agency Theory [3, 15, 22, 31] and Transaction Cost Economics
[9, 17, 28-30]. Based on these theories the internal and external coordina-
tion costs can be determined [12]. High external costs favour centraliza-
tion, high internal costs promote decentralization. It is typically assumed
that organizations in a supply chain choose their organizational structure
and network of trading partners in such a way that the sum of both costs is
minimized.

There has also been some debate on the impact of information technol-
ogy (IT) on the form of coordination. Early work by Malone et al. [19]
suggested that IT will lower transaction costs and therefore, ceteris pari-
bus, lead to an increase in market coordination. Later work posited that or-
ganizations will “move to the middle”, i.e. to “more outsourcing, but from
a reduced set of stable partnerships” [8] if non-contractible issues (e.g.
quality and trust) play an important role. Empirical evidence [14] shows
that companies often operate in a “mixed mode” blending aspects from
both markets and hierarchies.

But the majority of these studies was performed in the context of con-
ventional supply chains. In the face of a network topology the balance be-
tween hierarchical and market coordination needs to be readjusted: In the
absence of a central coordination unit we typically use the contract as an
instrument for coordination. Agency Theory suggests two principal forms of contracts, behavior-based contracts and outcome-based contracts. Between an employer and an employee, for example, a contract with a fixed annual salary would be behavior-based as such a contract demands that the agent performs to the best of his capabilities. An outcome-based contract would specify a remuneration that depends on the results that the agent has achieved (e.g. a commission). If the costs for monitoring agent behavior are high, an outcome-based contract is often superior. This is because an unobserved agent is assumed to shirk (i.e. underperform) knowing that he has no consequences to fear. This problem is called moral hazard. An outcome-based contract can be seen as a special case of a behavior-based contract where delivering the outcome is considered to be the only observable behavior of the agent. In addition to that, the costs for monitoring agent behavior have become marginal in many cases due to the omnipresence of information technology. These arguments apply also to the context of SBNs. We will therefore focus our investigation on behavior-based contracts.

3. Negotiation as a Social Process

We define negotiation as the process whereby a group of two or more individuals tries to reach an agreement on the performance of future actions. The individuals are human beings that might act on behalf of organizations or on their own behalf. For the purpose of this paper we focus on electronic negotiations, i.e. negotiations that are supported by information and communication systems. They can be divided into three different types: bargaining, auction and agent negotiation [18]. Auctions are very common, especially in electronic commerce. They assume that the traded products or services can be described in detail and are hence comparable. The auction proceeds in the form of a bidding process where potential buyers can make (money) offers for a certain product or service. There are different models to organize the bidding process [6]. A comprehensive classification of negotiations with respect to auctions is provided by the Montreal taxonomy [27].

Agent negotiation means that an inanimate agent, i.e. a software artefact, carries out the process of negotiation on behalf of a principal, typically a human being. The principal delegates the task of negotiating to the agent by providing it with his or her preferences regarding the product or service to be procured. The agent has a certain autonomy to act within the limits of these preferences. A number of models for agent negotiation is
given in [11]. The specification of preferences requires also that the product or service in question can be described in detail. Hence both auctions and agent negotiation work only with standardized products and services.

The models we have discussed so far assume that most parameters of the contract are already predetermined and very few can actually be negotiated. Most often the only free parameter is the price. In many cases this restriction is not acceptable, i.e. we need more freedom in negotiating. This can, for example, happen if the product or service to procure is not standardized so that we have to negotiate many of its parameters. In such a case we need the third model, bargaining. In bargaining we assume that in principal all parts of a contract are negotiable, i.e. we start with an empty contract (although existing reference contracts or contract templates can be used as a starting point if desired). A number of bargaining models has been suggested such as the Three-Layer Architecture [7], SilkRoad [26], DOC.COM [24], MeMo Business Negotiation Support Metamodel [10], Protocols for Electronic Negotiation Systems [16], and the Generic Model [20].

To find a suitable negotiation model for SBNs we must first identify criteria that such a model should fulfill. Based on the characteristics of a SBN mentioned above we have derived the following criteria: Communication, documents, deontics and time. The next sections argue for the necessity of these criteria.

3.1 Communication

The term communication is ambiguous. Communication takes place both on the business network level and on the communication network level but the meanings of the term in these contexts differ fundamentally. In the case of a communication network, communication is the central issue (hence the name). It consists primarily of an exchange of messages between inanimate agents, i.e. computers, IT systems or the like. On the other hand, communication in a business network consists of interaction between human beings (actors). Inanimate agents do not exhibit many of the qualities of human beings, such as conscience, responsibility, creativity and so on. This affects their ability to act as they cannot engage in social action, which requires these capabilities. Negotiating a business contract is an example for a complex social process that involves social actions, e.g. making commitments.

Communication is the primary instrument for social interaction in general and for negotiation in particular. Negotiation consists basically of an exchange of messages between the negotiators. With these messages the negotiators create, modify and extend the contract, e.g. by making requests
or commitments that ultimately lead to contractual obligations. It is therefore evident that a negotiation model for SBN contracts must incorporate communication on a fundamental level. The importance of language for social action has been recognized early which led to the development of several theories, most notably Speech-Act Theory [4, 25] and the Theory of Communicative Action [13]. Many of the negotiation models that address the issue of communication are based on these theories.

3.2 Documents

The result of negotiation is a contract, which is obviously a document. Contract and negotiation are duals of each other in the same way that document and communication are. They are so tightly interwoven that it is impossible to separate the one from the other. The contract is a negotiation cast into a document. A negotiation model must therefore provide some mechanism to derive the contract from the negotiation messages in a transparent and traceable way. But documents play an important role already during negotiation. Preliminary contracts (contract versions) are a record of the negotiations that have been made so far. In this sense documents are an embodiment of past communications. We need the contract versions to mark important achievements in contract development, to understand why the contract has developed in that particular way and to go back to an earlier version if something has gone wrong. As this holds for all types of contracts we can conclude that documents must form an integral part of the foundation of a SBN negotiation model.

3.3 Deontics

Deontic logic is concerned with reasoning about obligations and permissions. It has a direct bearing on negotiation as contracts are about determining obligations in exchange for granting permissions. For example, if Henry signs a contract about the sale of a car he enters into an obligation to pay a certain amount of money but in return he is granted the permission to take the car into his possession and to dispose of it in any way he wishes. Deontics trace the status of commitments during the course of a negotiation. As a rule an obligation arises only if all parties agree on it. If Sally commits herself to do the shopping she is not yet under any obligation. Mike might, for example, make a counter-offer to do it for her. Only if Mike accepts Sally’s commitment is she actually obliged to keep it. The same holds if Sally requests Mike to do the shopping. Her request alone does not put him under obligation, he might simply deny it. Only his agreement makes it an obligation. Keeping track of the deontic state is
therefore a must for any negotiation model, especially in the case of complex negotiations such as the ones involved in the design of a SBN.

3.3 Time

Time restrictions are an issue for many business actions. Some actions are not allowed to start before a certain point in time, others must be finished before a deadline has expired. A particular action might be required to be performed precisely at a specific time or repeatedly in certain intervals. It is therefore necessary that time restrictions for future actions can be negotiated as they are an important characteristic of the actions. But time-related issues are not only relevant at the level of the business process but also concerning the negotiation process itself. The time order of messages is relevant for the negotiation and the establishments of obligations and there are also time limits for the completion of the process. Our negotiation model should therefore offer a language that provides a concept of time.

4. Architecture of SBN Set-up and Operation

[18] has performed an evaluation and comparison of 11 negotiation models with respect to 11 criteria among which the above mentioned criteria can also be found. The closest match to the requirements for a SBN negotiation model is represented by DOC.COM [24] which fulfills three of the four criteria fully and one, deontics, at least partially. We have therefore chosen to adopt this model for the purpose of our study. As deontics is an important issue we have decided to add respective functionality to the negotiation system. But there is yet another problem that needs to be solved. The objective of DOC.COM is to represent a negotiation about the execution of a process instance, e.g. the delivery of a particular item on a particular date. But negotiations regarding the set-up and maintenance of a SBN concern process types, e.g. the general business logic of order processing. The resulting contract is called a frame contract as it regulates the interaction among network members regarding a significant number of orders over time. To enable such negotiations we have introduced a meta-layer into the negotiation language. Figure 1 shows the architecture of a system to set up and operate a SBN.
A SBN consists of a number of SBN members. Each such member is typically an organization (i.e. a business) but could also be an individual who acts as an economic agent. Each member organization is represented by a negotiator who is entitled to carry out such negotiations and to sign a binding contract on behalf of the organization. This negotiator will interact with negotiators from the other SBN members via a negotiation support system (NSS). The NSS consists of a message component and a contract component. The former handles both the translation of “human” negotiation messages into the formal representation in DOC.COM and the presentation of recorded formal negotiations in a human-readable form. The contract component stores the binding negotiations, which together make up the contract and which are also stored in DOC.COM, and represents this contract in a way that is similar to conventional, written contracts. The specific NSS for DOC.COM is called Negoisst [23]. The next section describes how negotiation and contract formation proceed.

The left part of Figure 1 shows how the operation of a SBN is supported. We assume that the process of negotiation has led to a contract that deals with all relevant issues of the cooperation. This could be the negotiation of a completely new frame contract, i.e. the set-up of a new SBN. On
the other hand the negotiation can also be about SBN maintenance which involves adapting to the loss of members, incorporating new members, replacing parting members, reacting to changed requirements or the like. The contract under consideration will in any case be subject to implementation which yields a description of the interactions between the members in some kind of workflow language. The choice of this language depends on the workflow system that we choose to coordinate the workflow between members. In principal any workflow system can be used that allows for the implementation of the workflow patterns identified in [2]. Most commercial systems qualify if we allow for workarounds and coding but there is little native support for many of the advanced patterns. Only FLOWer supports directly or indirectly 16 of the 20 patterns. In a prototypical environment it can be useful to employ YAWL [1] that provides all patterns but one, together with the YAWL Engine. YAWL uses the same serialization language as the negotiation and contract language DOC.COM, i.e. XML. This facilitates the implementation of the contract. YAWL makes also use of XQuery and XPath to extract data from XML input files and for generating XML output. This supports the integration with the enterprise application systems of the SBN members, most of which can import and export in XML format. The resulting workflow system is run on a co-ordination server which can be seen as part of a smart communication network. An example of this is given in the section 4.3 based on a YAWL implementation. An overview and comparison of other languages for interorganizational workflows is given in [5].

4.2 From Negotiation to Enactment

The previous section has described the general architecture of setting up and operating a SBN. In this section we describe how the procedures in that architecture are performed and what the results look like. For this purpose we consider a simple negotiation, the corresponding part of the contract and the resulting workflow net (enactment) in some detail. This example represents only a very small part of the case and just serves to illustrate the way our approach works. The complete example is shown in the next section on a more general level.
Our case involves three business partners: A retail chain in the home decoration industry (RetCom), the shops of this chain and a logistics company (LogCom). RetCom want that LogCom take over the delivery of orders for them. Figure 2 shows two steps in the respective negotiation between them. The representative from LogCom writes an email saying that they need a capacity reservation 2 weeks in advance of the order to be able to handle it. The negotiation support system helps with translating this request from the natural language to the internal, formal representation in DOC.COM:

REQUEST (Reserve_capacity[ORDER], \( t \leq \text{DATE}[\text{ORDER}] - 14 \))

The keyword REQUEST indicates that LogCom would like to introduce a new action into their cooperation. The propositional content of this message tells us what that action is, namely the reservation of capacity for each order. The request also specifies a time restriction for this action, i.e. 14 days in advance of the order date. This message is stored in the message
memory of the negotiation system so that it can be matched with RetCom’s reaction to it. In this case RetCom fully agree with the action that was suggested by LogCom by answering with “O.K.”. Again the NSS will help with translating this to the formal representation:

\[
\text{COMMIT} \left( \text{Reserve\_capacity[ORDER]}, t \leq \text{DATE[ORDER]} - 14 \right)
\]

The speech act COMMIT signals that RetCom agree to fulfil the request. A request that is followed by a commit with the same propositional content and restrictions leads to a binding obligation of the committing party towards the requesting party with respect to the content. An alternative reaction of RetCom could be:

\[
\text{COMMIT} \left( \text{Reserve\_capacity[ORDER]}, t \leq \text{DATE[ORDER]} - 7 \right)
\]

which would be interpreted as: “We agree to reserve capacity but we cannot do it earlier than one week in advance.” Such a speech act does not create an obligation but constitutes a counter-offer. An acceptance of this counter-offer by LogCom would then create an obligation concerning the modified terms. In our example the original request is granted and a respective obligation is inserted into the contract:

\[
\text{OBLIGATION} \left( \text{Reserve\_capacity[ORDER]}, t \leq \text{DATE[ORDER]} - 14 \right)
\]

The presentation component of the NSS can at any point in time display the contract that has been negotiated so far in a human-readable form (see Figure 2). In the final step the obligation is translated to a corresponding workflow.

4.2 Example

The example in the previous section was on a detailed level but covered only a small part of the case. Here we give a complete account of the case but leave out the details of the negotiation and the contract. We primarily focus on the architecture of the retail network before we performed our project (see Figure 3) and the result of applying the procedure described in the previous sections with the aim of making the network smart.
We started our project with performing an analysis of the business processes between the companies we have already mentioned. These companies had already an established business relationship that was based on a conventional frame contract. In the analysis we discovered the structure of the cooperation (see Figure 3) and a number of problems such as: broken interaction patterns, missing business rules, unclear communication structures, different contract interpretations and excessive interpersonal communication. As a consequence the parties were unsatisfied with the current situation.

To solve these problems we decided to create a smarter network to coordinate their interaction. We started with a negotiation of a formal contract. This was done in the form of a seminar where the representatives of each organization were present and the seminar leader manually translated their requests and commitments into a formal representation according to the procedure described above. This was done because the NSS does so far only support bilateral negotiations. But this restriction is, according to our
judgment, of a merely technical nature and it should be possible to extend the NSS to multi-part negotiation. The implementation of the contract was done with the help of YAWL and the YAWL engine which was run on a coordination server that connects all parties. The conversions between the involved formats (SAP, DISA, Extenda and Excel) have been performed with the help of XML Script and the X-Tract XML Script processor. This led to the network architecture depicted in Figure 4.

Figure 4: Smart architecture of the network

In the smart architecture each SBN partner only exchanges messages with the coordination server. This reduces the complexity of the coordination considerably. The server takes care of forwarding messages to the right recipients, converting between formats, triggering time-controlled messages and so on. The SBN architecture also offers ways to improve the efficiency of the communication. In our case, for example, the paper-based communication can be replaced by electronic messages, e.g. concerning the fax containing the pick list. The physical exchange between LogCom and the Shop can in this way be restricted to the exchange of the items themselves.
5. Conclusion

We started from the assumption that a SBN consists of a group of businesses that are linked via a business and communication network that is controlled by a multi-part agreement. Based on relevant theories we identified a suitable type of contract, i.e. behavior-based, and suggested an architecture to negotiate and enact such a contract. Negotiation is a social process based on interaction between human actors, each of them possibly representing an organization. The nature of social systems and their processes requires that we select an approach that supports human communication as well as documents (as records of human or artefact activity), deontics (as states in the social world) and time. Based on these requirements we arrived at a language for expressing both the process of negotiation and its result, i.e. the contract. This language is DOC.COM. For the enactment of the contract we need an interorganizational workflow management system and a corresponding language. For this step we can so far not make a suitable suggestion as the commercial systems do not provide sufficient support for all required workflow patterns, and the research prototypes do not (yet) possess the maturity and stability required in real-life business applications. To show the feasibility of our approach, we have used it to set up and operate a prototypical SBN.

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21. Towards Control Patterns for Business Networks

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Abstract

To keep a business network sustainable, controls are needed against opportunistic behavior of network participants. In this paper we develop a methodology for conceptualizing control problems and solutions, based on an economic value perspective. We introduce a library of control patterns, inspired by design patterns in software engineering. A control pattern is a generic solution for a common control problem. The relevance, consistency and effectiveness of some of our control patterns is demonstrated by a case study about the redesign of customs procedures.

Keywords: governance and control, design patterns, business modeling

1. Introduction

Companies increasingly form smart business networks (SBNs) to jointly satisfy a complex need. Well known examples include the networked business models of Cisco Systems and Dell [24]. A smart business network is a group of enterprises with joint goals, linked by network technology, that collaborate and interact in such a way that the network remains sustainable and robust to defection of one of the actors, and allows each actor to increase its own value [26, p.229]. To be sustainable, a smart business network needs governance and control measures, to prevent and detect opportunistic behavior of participants: a participant may leave the network, not fulfill its obligations, or commit fraud. From the early days of trade, inter-organizational control procedures have governed transactions between organizations against opportunistic behavior. These procedures rely on an exchange of control documents between parties [5]. Often the exchange of control documents creates an additional administrative burden. In the last few years, stricter security requirements from the USA especially, have led to a large increase in the administrative burden for trading partners. Infor-
nation concerning customs procedures, VAT and other excise duties is currently processed by separate information systems, even though the data is virtually identical. This has resulted in a large number of different documents associated with one single container crossing a border. Control procedures can be made more efficient by redesigning them and digitizing their contents. However, even when new procedures are implemented with advanced ICT solutions, they have to provide sufficient safeguards to ensure trustworthy transactions. So in order to support the design and redesign of control procedures for smart business networks, a structured approach is needed. For individual enterprises, approaches to design control procedures have been developed in the accounting field (e.g. [23,21]). But inter-organizational controls, as needed for a network of enterprises, have only received limited attention, with the exception of [5].

In this paper we make two contributions to the theory of developing control mechanisms for smart business networks. First, we present a conceptual modeling approach, called e³-control, to represent the control mechanisms along with the context and the control problem to which they are applied. Second, we present control patterns: a way to structure existing knowledge about the design of control procedures, and make it accessible for re-use.

To note, e³-control is a conceptual modeling design methodology. Conceptual modelling is well-known from the field of requirements engineering and plays an important role in research on electronic business modelling [4, 20, 25, 18]. The idea behind conceptual modeling is to conceptualize and formalize a certain domain. Each individual enterprise in a smart business network may interpret a control issue differently. It is therefore important to create a shared understanding of the control problems and the possible solutions, so that potential conflicts can be addressed and solved. Because enterprises have different interests, and there is no central decision authority in a network organization, an inter-organizational control problem is often complex. Stating and solving the problem therefore requires precise techniques, supported by software tools. Although various conceptual business modelling techniques address the design issues of business models for networks, they do not explicitly address the design of inter-organisational controls.

The e³-control methodology is based on the e³-value methodology for the analysis and design of business networks. Crucial in this approach, is that it applies a value perspective [9,11]. Using this methodology results in a value model of the business network, which determines the actors, such as enterprises or final customers, the value objects, i.e., objects or services of economic value that are exchanged between actors, and a profitability analysis, that states for each actor whether the exchanges result in a profit.
We assume that a sustainable smart business network requires a business model that eventually guarantees a profit for all actors. The value perspective can be opposed to a process perspective. The latter is conventionally used in the accounting literature to help design control mechanisms, control documents and information systems support. Crucially, value modeling focuses on what actors do and why, while process modeling focuses on how they do it [10]. It has been argued that value analysis forms an important step in the early stages of information systems design [20]. There are several reasons for using the value perspective, when looking at governance and control issues. First, the value perspective is conceptually close to Transaction Cost Economics, which studies safeguards against opportunistic behavior in contract relationships [28]. Because the $e^3$-value focuses on value, it enables a cost-benefit analysis of control mechanisms. This involves a risk assessment, which is typically part of accounting control practice (e.g. [23, 21]). Second, control mechanisms are themselves services, with an additional price tag. That raises questions like: who is going to pay for a control mechanism, who is going to execute it, and how will it affect the business models of the parties involved? These questions are not particularly relevant from an internal control perspective, but in a business network controls may affect the profitability of participants, or may even lead to new business opportunities. Third, some control documents have inherent value aspects, and can for example be traded and resold. Consider for example a Bill of Lading. As far as we know, the value modeling approach has neither been applied for design of internal nor for inter-organizational controls.

Previous research suggests that design of inter-organizational controls should include three steps: (1) make an initial analysis of the value model of the smart business network (value perspective); (2) identify the control problem, and (3) add control mechanisms to the initial value model [15]. How to execute step (1) has been discussed extensively, e.g. in Gordijn and Akkermans [9, 11]. Step (2), how to identify a control problem, has partly been dealt with by Kartseva et al. [15]. In this paper, we focus on step (3): the (re)design of a control mechanism to solve the control problem. Step (3) should include two sub-steps. The controls are based on principles related to business processes. Therefore, given the initial value model of a smart business network, we zoom in on the process level to design control mechanisms. This is step (3.1). Since many control mechanisms themselves are commercial services, their introduction may alter the value model. This is explored in step (3.2). Of the two sub-steps, we focus in this paper on step (3.1). The alteration of the business model will be explored in a separate paper.
In step (3), practitioners need guidelines on how to construct control mechanisms. The second contribution of this paper is therefore to present a well-defined and reusable methodology for designing control mechanisms for business networks. The core concept in this methodology is formed by a library of control patterns, which summarize accepted knowledge of inter-organizational controls. In general, a pattern is a description of a general and accepted solution for some recurring problem, which is applicable in a certain context. The pattern approach has been proposed in architecture [1], and has been successfully applied in software engineering [8]. More recently patterns have been proposed to capture aspects of business design like administrative processes [19], organization structure [7] and business process reengineering [3].

We are evaluating the relevance, consistency, and effectiveness of our library of control patterns through a series of case studies. In this paper, we present the Beer Living Lab, a case study that focuses on the redesign of customs procedures for collecting excise duties. Possible redesigns rethink why network partners work as they do, and how to use technological innovations, like a secure tracking and tracing device, to handle control problems in the network. The Beer Living Lab can be categorized as an observational case study: the ‘artifact’ is studied in depth in the business environment [12]. In our case the artifact is a combination of control patterns, and business models for smart business networks. Based on the description of the case and on the control patterns, we generated a reference model. The reference model prescribes the way controls should be designed according to the theory. The reference model was then compared with real life scenarios, provided by the domain experts.

The remainder of the paper is organized as follows: Section 2 presents the theoretical background of our work: control theory and conceptual modeling. In Sections 3 we present the notion of a control pattern and in section we present a library of control patterns. Section 5 describes how we use and implement control patterns in a case study about the redesign of customs procedures. Section 6 contains the conclusions.

2. A theoretical background

2.1 Control theory

To our knowledge, structured methods to design documentary control procedures are limited to the field of accounting, and in particular to internal control (e.g. [23,21]). In accounting control, the selection of a control mechanism is based on a preliminary identification of a control problem.
Control problems are typically identified by an analysis of risk indicators and threats discovered in an audit process. For example, a control problem is that an employee may steal inventory. The corresponding control mechanism is to have periodic inventory checks, and to allow access to inventory only to authorized employees. A control mechanism is thus a procedural guideline on how to organize business processes in order to avoid or reduce the risks posed by a control problem. To identify the problems and controls in an organization, the accounting control literature relies on a rigorous analysis of internal business processes. A general assumption is that every activity in an organization is a potential source of control problems.

It has been argued that internal control literature is also relevant for the design of inter-organizational control procedures [5]. This may still be true, but because the purpose of internal control is different from inter-organizational control, it is difficult to apply the theory directly. In addition, there is no common ontology, which also makes it difficult to reapply the theory to inter-organizational processes. Bons et al.[5] take a more formal approach to the design of controls. Based on Chen’s [6] review of the internal control literature, they present a set of auditing principles (Table 1), which were implemented in a computer system to perform an automatic audit of business processes. The automatic audit would detect weaknesses, by analyzing a process, and checking whether the principles apply.
I. Whenever an operational activity exists, a corresponding verification activity should also exist.

II. Whenever an operational activity and its corresponding verification activity exist, the verification activity should follow the operating activity.

III. When a verification activity exists, it must be furnished with supporting documents.

IV. The supporting document should be the result of a previous verification activity.

V. Supporting documents should be generated by a source independent of the source which generates the document to be verified.

VI. If a control activity uses a supporting document, the supporting document should be transferred directly from the verification activity that produced it.

VII. A verification activity and the operational activity it intends to control should be segregated into two different positions.

VIII. A verification activity and the operating activity it intends to control should be delegated to two different agents.

IX. The position responsible for a verification activity must not be lower in the formal power hierarchy than the position of the operational activity to be controlled.

X. The agent responsible for a verification activity should be socially detached from the agent responsible for the operational activity to be controlled.

Table 1: Audit principles of Chen [6], adapted for readability and consistency of terminology

Chen focuses on the verification of activities. He uses a specific terminology. A verification activity (or control activity) verifies the correctness of the result of an operational activity, which is a potential source of risk. A supporting document is needed to make a decision about the correctness of the operational activity. For example, if we must verify whether the delivered goods were also ordered, we can use the purchase order as a supporting document. The principles can be clustered as follows. Principles I and II are about the precedence order of activities. Principles III - VI put additional requirements on the supporting documents. For example, principle VI requires direct transfer. This is crucial to avoid possible tampering, because a very high percentage of fraud cases involve alteration of otherwise valid documents. Principles VII - X are concerned with task as-
signment, and ensure segregation of duties. Because Chen focuses on risks related to purchasing and payment, not all controls can be expressed by these principles. For example, order authorization to prevent ordering goods from sellers with a bad reputation, cannot be derived by these verification principles. In Section 3 and 4, we identify a broader set of control mechanisms, and describe their application by means of control patterns. Based on the principles of Chen, we provide an extended set of guidelines for the application of a specific pattern.

2.2 Conceptual Modeling of Controls

In the accounting control field, when designing controls, risk indicators have to be taken into account. Therefore, we must distinguish two states of a network of organisations: (1) the ideal situation, in which no errors, opportunistic behaviour or fraud occurs, and (2) a sub-ideal situation, in which errors, opportunistic behaviour or fraud does occur [15]. In accounting control, the ideal and sub-ideal situations are analysed by means of process models. In our methodology, we define ideal and sub-ideal situations in terms of value models, and the principle of economic reciprocity.

2.2.1 Ideal value models

An $e^3$-value model is a model of value exchanges between enterprises in a smart business network. An $e^3$-value model incorporates modeling concepts to represent which parties in a value constellation, exchange which objects of economic value with which other parties [9,11]. Figure 1 shows an example of a buyer who obtains goods from a seller and offers a payment in return. According to the law, the seller is obliged to pay value-added tax (VAT). This can be conceptualized with the following $e^3$-value constructs (in bold). Actors, such as the buyer, seller, and the tax office are economically independent entities. Actors transfer value objects (payment, goods, VAT) by means of value exchanges. For value objects, some actor should be willing to pay, which is shown by a value interface. A value interface models the principle of economic reciprocity: only if you pay, you can obtain the goods and vice versa. A value interface consists of value ports, which represent that value objects are offered to and requested from the actor’s environment. Actors may have a consumer need, which, following a path of dependencies, will result in the exchange of value objects. Exchanges may be dependent on other exchanges, or lead to a boundary element.
2.2.2 Sub-ideal value models

In e³-value it is assumed that actors behave in an ideal way, meaning that all value exchanges occur as prescribed. This implies, among other things, that actors respect the principle of economic reciprocity. In sub-ideal situations, actors may not behave as stated in an e³-value model; they can commit fraud or make unintentional errors. In e³-control, which has been suggested as an extension of e³-value [15], these situations are modeled by sub-ideal value exchanges. These are graphically represented by a dashed line, which indicates the possibility of different risks, e.g. that actors will not pay for the goods, not obtain the goods, or obtain the wrong goods.

2.2.3 Process models

The control principles described in section 2.1 are mainly based on business process-related measures. Take for example the verification activity, or the transfer of an evidence document. The temporal order in which activities take place is also a part of controls. In order to capture how controls alter a value model, we first need to understand how they alter the corresponding business processes. To represent process aspects of control problems we need a graphical notation. For this purpose we use UML-activity diagrams [22].

3. Control Patterns

We organize existing domain knowledge about inter-organizational controls by means of so called control patterns. The idea of a control pattern is
inspired by design patterns in other fields. In general, a design pattern is a
description of a general and accepted solution for some recurring problem,
which is applicable in a certain context. So patterns provide a structured
way of encoding the best practices that exist in a certain field. Such struc-
tured approaches are necessary, because domain experts often find it hard
to make their knowledge explicit, and explain why a certain solution was
chosen. The pattern approach has been proposed in architecture [1], and
has been successfully applied in software development [8]. Because of this
success, patterns were subsequently used to capture the design of adminis-
trative processes [19], the design of organization structures [17] and to
guide business process reengineering [3]. Each of these applications in-
volves a design aspect, and a more or less structured and well documented
business environment. We believe that the design of control procedures
falls in the same category.

Traditionally, a pattern has the following structure [8]:

Name: should be well chosen to describe a specific problem area
Context: describes the context of the application of the pattern
Problem: describes the problem which requires the application of the
pattern
Solutions: describes the object and/or cases that constitute the solution
for the problem

Other items that can be in a pattern are links to related patterns, a set of
prototypical examples, and a set of forces and variations. Forces describe
aspects of the context that may lead to a variation of the solution for a
similar problem. Translated to the domain of control theory, the definition
of the patterns is the following.

Definition 1. A control pattern is a generic and re-usable control mecha-
nism for a recurring control problem, selected on the basis of aspects of the
context of application. The structure of a control pattern is the following:

1. name: the name of the pattern
2. context: a description of the value constellation to be controlled,
modeled from an ideal perspective, meaning that no one behaves opportu-
nistically.
3. problem: a statement of one or more the control problems, illustrated
by scenarios that demonstrate a risk for opportunistic behavior, repre-
sented by a sub-ideal value model and a process model for the value con-
stellation.
4. solution: a control mechanism, described by guidelines and illustra-
tions of their implementation in process models and value models. A solu-
tion may have different variations, along with forces, which are conditions
to select these variations.
5. related patterns: a list of patterns that are *used* by the current pattern, or *use* the current pattern.

6. application guidelines: a list of principles, that provide additional constraints on the way patterns are combined together.

The context should provide a background to the control-problem and its solutions. The context explains what is considered to be the norm. Controls should prevent, detect or correct any behavior not allowed by this norm. This normative ideal behavior is described with value models, stating *what* economic value the actors exchange, not *how* they should exchange it. A control problem exists if there is some deviation of the prescribed exchange of economic value, e.g. the wrong products are delivered, or no products are delivered at all. Therefore we model the context by an *ideal value model* (see section 2.2.1).

The problem states of one or more control problems. Following the accounting literature, a control problem is defined by one or more risks. Typically, a risk for opportunistic behavior is illustrated by one or more scenarios that display a violation of the ideal model. Fraudulent or undesired behavior can be represented by a *sub-ideal value model*. This is a value model that explicitly records potential violations, from a value perspective (see section 2.2.1). To understand a control problem, and to select appropriate solutions, we have to understand the inter-organizational business processes associated with a sub-ideal value model. To represent process models we use UML activity diagrams (see section 2.2.3).

The solution describes a control mechanism. In case a solution fully solves the control problem, it can be specified by means an activity diagram that shows how the control mechanism works. The value model may also have to be altered. Given the context and problem descriptions, different ways of implementing a solution to the same problem are possible. For design patterns, such alternatives are known as *variations*. The reason that determines which variation of a solution must be implemented, is called a *force*. Forces are constraints on the context of application. In case studies, variations prove to be useful: they can express differences, which are not crucial enough to warrant a separate pattern.

The list of related patterns indicates relationships with other patterns. Very often, patterns occur together, or use each other.

The application guidelines provide a set of principles about the interpretation of a context of application, which must hold for the pattern to be applied correctly. Not all constraints can be expressed using a graphical notation. For example, segregation of duties, or quality of information requirements, could otherwise not be expressed. In the patterns that are discussed in this paper, the guidelines are based on the principles of Chen [6] and Bons et al.[5], as discussed above. Typically, the guidelines come
in three parts: (1) guidelines about precedence order of activities, (2) guidelines about control documents, and (3) guidelines about task assignments and actors.

### 3.1 Pattern vocabulary

To describe the patterns, we need to define our conceptualization of inter-organizational control. From an inter-organizational perspective, controls and risks are assessed from the point of view of one actor: the so-called primary actor. The primary actor is dependent on another actor, the counter actor, who may behave opportunistically. The primary actor therefore designs mechanisms to control the counter actor’s activities. In our patterns we use the following vocabulary (Figure 2).

<table>
<thead>
<tr>
<th>Value perspective</th>
<th>Process perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image.png" alt="Value perspective diagram" /></td>
<td><img src="image.png" alt="Process perspective diagram" /></td>
</tr>
</tbody>
</table>

**Figure 2 Patterns vocabulary**

The primary actor must perform a **primary activity**, which results in a transfer of a value object, called **primary object (PO)**, to the counter actor. The counter actor must execute a **counter activity**, which results in a transfer of a value object, called **counter object (CO)**, to the primary actor. In value models we model a reciprocal value exchange of the two value objects PO and CO. In the process perspective, the transfer of the value objects PO and CO corresponds to two activities called primary activity and counter activity, performed by the actor with the outgoing value port. The order in which these activities occur is not specified. This is indicated by the UML notation for parallel execution (thick bar), which is often given a so called *interleaving* semantics. The control activity that is considered in detail in this paper is a **verification** activity. It controls the outcomes of the counter activity or a document, with information about the outcome of the counter activity. The verification involves not only the ac-
curacy of the document, but also the legitimacy of the actions [6]. Verification can be performed by means of witnessing or reconciliation [21]. **Witnessing** can only be performed if the primary actor has direct access to the outcome of the counter activity. **Reconciliation** compares two documents: a supporting document and the to-be-verified document. The **supporting document** contains trustworthy information about what the outcome of the counter activity should be. In some cases the primary actor delegates his activities to another actor, called **Trusted Third Party** (TTP).

### 4. Patterns library

In this section we present a library of control patterns (Table 2). As always, we take the primary actor as the point of reference. We do not claim that the library is complete for all inter-organizational problems. The set of patterns we consider is limited by our elicitation method (see section 4.1).

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Risk of the primary actor</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>receipt</td>
<td>counter actor may claim that primary activity was not executed</td>
<td>require testifying of execution of primary activity</td>
</tr>
<tr>
<td>pre-execution</td>
<td>counter actor may not execute counter activity according to contractual agreement</td>
<td>require verification of counter activity before executing primary activity</td>
</tr>
<tr>
<td>post-verification</td>
<td>counter actor may execute counter activity in the wrong way</td>
<td>require verification of counter activity after execution of counter activity</td>
</tr>
<tr>
<td>verification</td>
<td>a &lt;verification&gt; activity introduced by another pattern, lacks evidence and standards</td>
<td>verify correctness and completeness of the results of an activity, against given standards</td>
</tr>
<tr>
<td>commitment confirmation</td>
<td>counter actor may deny that he made a commitment</td>
<td>require confirmation of commitment from counter actor before executing primary activity</td>
</tr>
<tr>
<td>commitment authorization</td>
<td>counter actor is an unauthorized vendor (e.g.</td>
<td>require authorization to make a commitment before</td>
</tr>
</tbody>
</table>
Table 2: Library of Control patterns

<table>
<thead>
<tr>
<th></th>
<th>sells goods of wrong quality, at inflated prices etc.)</th>
<th>accepting conformation of commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>compensation</td>
<td>counter actor did not perform according to agreement (corrective control)</td>
<td>in case of sub-ideal exchanges, require compensation of value from the responsible actors</td>
</tr>
</tbody>
</table>

The patterns are also related to each other (see Figure 3). For example, both ‘post-verification’ and ‘pre-execution’ make use of the pattern ‘verification’. This pattern specifies additional constraints on the context and on the documents needed in a verification activity. Because these constraints are generic for all verification steps, we did not want to repeat them for very individual pattern. In the diagrams, this is indicated by the notation `<verification>`, to illustrate that this activity is effectively a variable which needs to be supplied with more specific activities, like witnessing or reconciliation.

![Figure 3 Relations between patterns](image-url)

### 4.1 Pattern Elicitation

To extract the patterns, we performed an in-depth literature review as well as multiple case studies. First, we took patterns from literature on formal models of internal and inter-organizational controls. The patterns ‘receipt’ and ‘pre-execution’ are discussed in [5] and [27], and the pattern ‘commitment confirmation’ is discussed in [27]. Next, we verified these
patterns with a broader literature review, which confirmed that these patterns do appear several times in different cases. In addition, several other patterns were discovered. This literature review was based on the text books in the field of internal accounting and control (among others [21, 13, 2, 23]). After the extended set of patterns was extracted, they were applied in a series of case studies. The case studies were performed in different sectors, namely in the fields of internet radio [14], renewable energy [15], international trade [17], and health care [16]. As a result, the patterns in the library were updated. In this paper we will apply the patterns in yet another case study.

In the next two sections, the patterns ‘post-verification’ and ‘verification’ are presented in detail. These patterns are used in the case study in Section 5.

4.2 Pattern “Post Verification”

This pattern deals with risks often considered in accounting literature. For example, it is a risk for a buyer to accept goods or services that were not ordered, to accept damaged goods, or to accept payment for the wrong amount of goods or services. The control mechanism, suggested by the accounting literature, is to verify the correctness of the goods delivered, or the amount on the invoice with what was agreed, or what was actually delivered.

Name: post verification

Context: Primary actor and counter actor exchange value objects PO and CO. Primary actor does not trust the counter actor.

Problem: Counter actor, if not controlled, may deliver bad quality, the wrong quality or the wrong type of counter object (CO).

Solution: Primary actor must ensure a verification activity is executed, after the counter activity has been executed. The verification activity controls the result of counter activity.

Force a: the primary actor has direct access to the results of the counter activity, for example by means of a document

Variation a: add a <verification> activity, executed by the primary actor

Force b: the primary actor has no direct access to the results of the counter activity, but there is a party trusted by the primary actor (TTP), who does have direct access

Variation b: <verification> is delegated to a trusted third party (TTP), who transfers an evidence document with the result of the verification activity to the primary actor.
**Related patterns:** this pattern uses the pattern “Verification”, which puts further constraints on the `<verification>` activity, and the required evidence and documents for that.

![Verification pattern](image)

**Figure 4: Verification pattern**
Application Guidelines: In short, the principles emphasize the following details. First, the <verification> activity can be either witnessing (Solution a), or reconciliation (Solution b). In Solution b, the reconciliation activity has to reconcile an outcome of the counter activity with some supporting document (Chen’s principle III), which states what the outcome should be. The outcome of the counter activity can also be represented as a document, which is called to-be-verified document (Chen’s principle V). The supporting documents must be an outcome of some other <verification> activity, which has to occur before reconciliation (Chen’s principle IV). Finally, the supporting document has to be sent directly to the reconciliation activity (see principle VI of Chen). The Internet Radio case [14] provides an interesting case of a combination of the patterns ‘post verification’ and ‘verification’. The verification is done between three parties: a listener, a rights society and a radio station. The listener provides data to the rights society about the music downloaded by him. These data are used as a supporting document for the rights society, to check how many music rights were executed by the radio. This in turn determines the fee to be paid by the radio station to the rights society. An exchange of evidence documents in the healthcare case [16] can also be captured by these two patterns.

5. Case Study: Beer Living Lab

In this section we evaluate the relevance, consistency, and effectiveness of our library of control patterns through a case study: the Beer Living Lab. The study focuses on the redesign of customs procedures for collecting excise duties.

5.1 Research Method

The use of the control patterns was studied in collaboration with domain experts. We had frequent access to domain experts from the Dutch Customs and Tax Office, and also to experts from a large beer producer in the Netherlands. Hence, the Beer Living Lab can be categorized as an observational case study [12].

The study was designed as follows. First, an initial analysis was made of the case, on the basis of interviews with domain experts and additional documents. In this initial phase, we identified the various actors involved, the objects of value they exchange and made a partial analysis of the business processes regarding excise duties. Second, we derived a reference model, by applying the control patterns to the initial case description. A
reference model prescribes control mechanisms that should be implemented in a certain situation. One could say that a reference model is a kind of hypothesis, generated by straightforward application of the patterns. Third, the reference model was then compared with a number of real life scenarios, provided by the domain experts.

Control patterns are not descriptive, but prescriptive: they prescribe how control mechanisms ought to be designed. This makes it hard to use standard empirical research methods. So there are two possible ways in which real life scenarios can deviate from a reference model: either the model is wrong, or else ‘reality is wrong’, i.e. we can identify some remaining control problem. We say that the model is wrong, when the reference model predicts that a control problem is dealt with by a particular control mechanism, but this mechanism can not be found in real life, and the domain experts do not think that a serious control problem remains. On the other hand, we say that a control problem remains, when the expected control mechanism can not be found in real life, but domain experts acknowledge that this forms a serious control problem.

5.2 Case Description

When goods like beer and cigarettes, called excise goods, are sold, the seller needs to pay a special tax called excise. The general principle is that excise only has to be paid in the country in which the excise good is sold and consumed. Hence, if a beer producer in the Netherlands, say BeerCo NL, is exporting beer, possibly via the business unit BeerCo UK, to a retailer in the UK who sells the beer to English consumers, excise has to be paid by the English retailer to Customs and Excise UK\textsuperscript{17}. In this case, the beer producer in the Netherlands can export excise-free. Clearly, this is only acceptable for the Dutch Customs and Tax Office, if the beer producer in the Netherlands can prove that the goods were shipped outside the Netherlands. The procedures currently revolve around the exchange of paper documents. The core document for this excise-free export procedure is the Administrative Accompanying Document (AAD). This document is signed by a so-called excise warehouse in the UK. Customs and Excise UK (HMRC) subsequently signs the AAD, to confirm that the goods did indeed arrive in the UK. Finally, the AAD is returned to the Dutch beer producer as evidence that the goods have arrived in the UK and will be presented to Dutch Customs and Tax upon request.

\textsuperscript{17} Note that in some countries excise is considered a tax issue, while in other countries it is considered a customs matter; we therefore refer to Tax and Customs organizations interchangeably.
5.3 Ideal Value Model

When BeerCo NL exports beer to the UK, no excise is due in the Netherlands. When BeerCo NL can prove excise free delivery outside the Netherlands, it is exempted from excise duties and is considered compliant with the law (see exchange between BeerCo and Customs NL in Figure 5). BeerCo UK sells the beer to a Retailer with EW: a retailer licensed for the excise warehouse function. The retailer with EW sells the beer to UK supermarkets, for a price that covers the excise, and pays excise to Customs UK. Figure 6 shows a partial process model that corresponds with the business model in Figure 5.

Figure 5 Ideal business model for beer export
5.4 Sub-ideal value model

A sub-ideal business model identifies control problems in the initial, ideal business model. In our case, BeerCo NL delivers beer also to consumers in the Netherlands, for which it does have to pay excise to Customs NL. BeerCo NL could commit fraud by declaring the export of beer which had in fact been sold in The Netherlands, and getting an excise exemption for it. This is a violation of the law, because beer sold in the Netherlands cannot be declared excise free. Control mechanisms can detect and prevent such behavior.

5.5 Reference Model

We consider the control problem that BeerCo NL can declare to have exported beer that it had actually sold in The Netherlands, and for which excise is due in the Netherlands. This control problem can be mitigated by means of the patterns “post-verification” and “verification”. Figure 7 shows the result of applying these patterns to the original model in Figure 6: a trusted third party (TTP), trusted by Customs NL, has to witness and provide evidence to Customs NL that the beer was indeed exported. Only with this evidence can the beer be declared excise free.
Figure 7 A reference model with controls

We added two control activities in Figure 7: “Verify free excise” and “Witness export”. The “Verify free excise” activity verifies if the beer declared by BeerCo NL to be excise free, was indeed exported. This activity is executed by Customs NL. We chose here for solution b from pattern ‘Verification’. According to solution b, reconciliation, two sets of documents are compared.

The Excise Declaration plays the role of document-to-be-verified. In order to verify this declaration, the “Verify free excise” activity requires evidence that the beer was indeed exported. This evidence is provided here by means of supporting documents, delivered by some trusted third party. The most elegant case would be when witnessing the export is also performed by Customs NL, who have a direct interest in this control. But since officially there are no borders between EU member states, customs administrations cannot physically follow the export of goods. So Customs NL must delegate the witnessing activity to some other trusted third party (TTP). There are a number of constraints on the application of the patterns. The supporting documents must be provided by a party independent and socially detached of BeerCo NL. This is to prevent BeerCo NL from manipulating supporting documents (Chen’s principle VIII, X). In addition, the supporting documents have to be based on a witnessing activity, with direct access to the activity to be verified. The supporting documents should be transferred directly from the activity which generates them to the...
activity which intends to use them as supporting documents (Chen’s principle VI).

In different scenarios, many actors can play the role of TTP and supply the supporting documents, as we will demonstrate. Thus, the process model in Figure 7 acts as a reference model that can be instantiated in different ways, by specifying which actor performs the TTP’s activities.

5.6 Real-world scenarios

In this section we examine current and future export practices, and compare them to the reference model. The AAD is a supporting document as described by the pattern “verification”. In the AAD scenario (see Figure 8), the role of the TTP is performed by Customs UK or by a Retailer with EW. In fact, Customs NL delegates the witnessing of export to Customs UK or to the EW, and relies on the AAD document to verify export. The difference between the reference model (see Figure 8) and current practice is that in reality AAD is not transferred directly to Customs NL. The AAD is transferred first to a shipping company (not modelled), then to BeerCo NL, and then to Customs NL. This indirect transfer violates Chen’s principle VI, which says that the supporting document AAD should be transferred directly to Customs NL, to prevent manipulations of the AAD. Only if a supporting document cannot be forged (which is not the case here), is an indirect transfer acceptable. At the current state, the AAD can be forged. According to the domain experts, this diversion from the reference model indicates a real and existing control problem.
We have also performed an analysis of other real-life scenarios, including export to the USA, where export procedures are different from those in the EU, and export using the EMCS system. The EMCS system is a new Europe-wide information system for excise movement control. These scenarios proved to be instantiations of our reference model. Just like in the AAD case, we were able to identify risks in the real-world models by comparing them to the reference model, and validating our findings with domain experts. The control problem with the AAD that is vulnerable to tampering, can be solved by means of advanced technology, in particular, by the TREC device that is currently developed. TREC (Tamper-Resistant Embedded Controller18) is a device that, when attached to a freight container, can be used to detect unauthorised opening of a container. It is intended to reduce fraud and increase security. By monitoring a container’s position coordinates, an automated message can be sent to Customs NL when the container actually leaves The Netherlands. TREC devices could therefore replace the AAD’s functionality as evidence of export. Because the TREC technology is still under development, we propose a possible implementation of this scenario based on our reference model. In our terminology, the TREC device performs the role of TTP. It improves the witnessing activity because it can send an electronic message at the exact

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18 Further information on TREC is available at http://domino.research.ibm.com/odis/odis.nsf/pages/board.06.html
moment when the container actually crosses the border. By contrast, the AAD would typically be returned to BeerCo NL after one or two months. Figure 9 is another instantiation of our reference model. It shows that the TREC device performs the “Witness export” activity and sends a message directly to Customs NL.

A pre-requisite for this scenario is that the party operating the TREC device complies with characteristics of a TTP. It has to be independent and socially detached from BeerCo NL on the company level and on the employee level. This refers to the risk that an employee can send a message about crossing the border while the border was not crossed. Therefore, a TREC device must send a message about border crossing without human intervention.

5.7 Lessons Learned

What can we learn from the case study? Regarding the redesign of customs procedures for excise duties, we can conclude that the current EU practice is vulnerable. The AAD, which should prove that goods have indeed left the country, is transferred along the supply chain, and can therefore be tampered with. This control problem can be mitigated in several ways. One of these involves a technical device, the TREC, and a new actor, the TREC service provider. The export procedure that involves TREC is currently being designed as an instantiation of our reference model.
Regarding the use of the control patterns, we can make some initial observations about relevance, consistency and effectiveness. There is a general trade off between relevance and generality. Patterns must be formulated in such a way, that they can be generalized to different contexts, but if you generalize too much, patterns are no longer relevant. We believe that the case study shows that the control patterns in our library are not too general, but are indeed relevant: they helped to reveal real control problems, and a possible solution. The case study also showed that the patterns can be applied consistently in a complex domain. Consistent application requires that the application guidelines are observed. Finally, the patterns have proved effective, in summarizing existing principles and ideas in a concise format, and communicating them with domain experts. Although the graphical notation has its limits, it certainly helped to reveal crucial aspects of the business models and processes. To overcome the limitations of the graphical notation, we developed some modeling guidelines about the level of granularity of the activities, or how to refer to evidence documents.

6. Conclusions

Information technologies enable organizations to collaborate in new and smart ways to deliver a combined solution for some customer need. Business models are used to express, analyze and communicate the rationale behind the collaboration in such smart business networks. In order to be sustainable, smart business networks need mechanisms for governance and control. However, existing approaches for the analysis and design of business models do not address the risk of fraud or network participants who fail to live up to their commitments. Such opportunistic behavior can be detected and prevented by incorporating explicit control mechanisms in the inter-organizational business processes that regulate transactions in the network. In this paper we make two contributions to governance and control issues in smart business networks.

First, we suggest $e^3$-control, a three-step approach for the design of control mechanisms: (1) Design an initial business model. This model is interpreted as an ideal situation, in the sense that participants behave as expected. (2) Identify control weaknesses and threats, to show that the network has a serious control problem. A control problem is interpreted as a deviation from the ideal business model: a sub-ideal situation. (3.1) Add control mechanisms to the inter-organizational business processes, in order to detect or prevent the control problem, and (3.2) update the business
model according to the new control mechanisms. Step 1 and 3.2 of our approach use a value perspective to analyze and redesign business networks, while step 2 and 3.1 use a process perspective to analyze and design control mechanisms.

Second, we structure existing domain knowledge about inter-organizational controls by means of control patterns. The primary intent of a pattern is to provide a useful abstraction of an existing solution to a recurring problem, for the sake of reuse. The control patterns are used to design a reference model. Such a reference model can then be instantiated in various ways, involving different actors. The reference model helps to verify whether existing business processes adhere to the control principles underlying the control patterns, or still pose serious control problems.

We demonstrated how to put theory into practice by a large scale case study about the redesign of customs procedures regarding excise duties: the Beer Living Lab. By applying control patterns we created a reference model, revealing that current EU practice is vulnerable to fraud. Furthermore, the reference model is used in a project in which businesses and governments participate to design new customs procedures, in which a new actor, the so called TREC service provider, assumes the role of TTP. The new export procedure is being designed such that it is an instantiation of our reference model. An expert panel consisting of representatives of the participating organizations confirmed that the reference model, which is based on application of the control patterns, does manage to mitigate control problems in the business network. One of our scenarios introduces a new actor: the TREC service provider. That means that the initial business model of the business network has to be changed, and that the financial feasibility of the new business model must be closely examined, as in step 3.2 of our approach. These issues will be discussed in a separate paper.

From a theoretical perspective, the e³-control approach is innovative in several ways. First, the purpose of e³-control is to assist in the design of inter-organizational controls in a systematic way. For this we use conceptual modeling techniques well-known in software engineering. To facilitate the design process we propose a library of control patterns to structure existing knowledge to make it transferable to the inter-organisational domain, which is a contribution in itself. The control patterns are based on a thorough review of accounting control literature. In addition, we also use literature on formal models of control principles to describe the patterns (Bons et al. 1998; Chen 1992). Our contribution differs from this literature, because we aim for a methodology to design new control mechanisms, instead of checking the correctness or trustworthiness of existing control procedures.
Finally, one of the objectives of our design approach is to enable evaluation of the impact of control mechanisms on the business models that underlie smart business networks. This is innovative compared to the field of internal control, where, conventionally, only process models are looked at to design controls, and no conceptual modeling tools are used to perform a cost-benefit analysis. For this purpose we use the e³-value methodology, which enables application of scenario techniques to evaluate and compare different control mechanisms from a value perspective.

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References


22. Intelligent Integration of Supply Chain Processes based on Unique Product Identification and a Distributed Network Architecture

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1. Introduction

The emergence of new technologies, such as Radio Frequency Identification (RFID), is expected to revolutionize many of the supply chain operations by reducing costs, improving service levels and offering new possibilities for identifying unique product instances. The advanced data capture capabilities of RFID technology coupled with unique product identification and real-time information coming from different data sources, such as environmental sensors, define a new and rich information environment that opens up new horizons for efficient management of supply chain processes and decision support.

The expected benefits from the use of RFID technology are to grow substantially if the scope of implementation is extended from internal warehouse and distribution processes to supply-chain processes involving collaborating partners. Currently, RFID implementations take place internally within a company mainly with the objective to automate warehouse and store management processes in the first run. The priority and effort placed behind such implementations by the US Department of Defence and global retailers such as Wal-Mart, METRO, TESCO etc. combined with the pressure they put on their suppliers indicate that this technology has already become a market mandate.

However, on the suppliers’ side, RFID, as a tag that has to be placed on their products, is often considered to be an unfortunate strategic necessity
(Barua et al. 1997) they have to comply with in order to satisfy the plans of their big customers for increased internal efficiency. For suppliers to benefit from RFID they need to share RFID information with their partners and exploit this information in order to streamline supply chain processes and gain new market knowledge (Subramani 2004).

Despite this widely-shared notion among suppliers, the efforts aimed at enabling the exchange of RFID information between supply-chain partners are still in their infancy, with the EPC Network and the ONS infrastructure as the most notable movements towards this direction (Shih et al. 2005). A recent report consolidating the views of industry leaders and many different companies on a global basis (GCI 2005) identifies the need to establish clear information-sharing work practices and infrastructures between trading partners to support the use of free, standards-based information exchange and collaborative decision-support, enabled by RFID technology. In this context, the specific paper discusses how a distributed network architecture building on the possibilities provided by web-service orchestration, data-stream management systems and smart-tagging technologies, can be employed to enable collaborative supply-chain management processes and decision making.

Based on the outcome of a design research approach as well as on the results of a field survey, the paper discusses, on one hand, the network design and the selection of the proposed technologies from a technical perspective and, on the other, the relevance of RFID-enabled collaboration and decision-support scenarios to industry executives, including the associated benefits and barriers, from a broader research perspective.

In the following section we look closely into the technology of RFID and the way it is employed in supply chain management. Section three then describes the proposed architecture and tries to explain why the selected technologies have been employed in order to support RFID-enabled collaboration and decision support. Section discusses the relevance of specific collaboration scenarios to industry executives as well as the expected benefits and barriers associated with each scenario. Section five concludes with an overall critique and suggestions for further research in this area.
2. Employment of RFID technology in supply chain management

Radio Frequency Identification (RFID) is a technology that uses radio waves to automatically identify objects. The identification is done by storing a serial number, and perhaps other information, on a microchip that is attached to an antenna. This bundle is called an RFID tag. The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can be passed on to an enterprise information system.

RFID technology has been extensively used for a diversity of applications ranging from access control systems to airport baggage handling, livestock management systems, automated toll collection systems, theft-prevention systems, electronic payment systems, and automated production systems (Agarwal 2001); (Hou et al. 2006); (Kelly et al. 2005); (Smith et al. 2003). Nevertheless, what has made this technology extremely popular nowadays is the application of RFID for the identification of consumer products and the management of supply-chain processes.

Traditionally, the retail sector uses barcodes as the main identifier for cases, pallets and products. Today, over 5 billion products are scanned every day in 141 countries. However, many in the industry are already looking to the business case of RFID as the “next generation of barcode” through its ability to identify products automatically not requiring line-of-sight and store much more information, thus enabling mass serialized identification of every single product instance in the supply chain. The Electronic Product Code (EPC) is the standard adopted in this case.

In the retail supply chain, RFID can potentially empower a broad spectrum of applications, ranging from upstream warehouse and distribution management down to retail-outlet operations, including shelf management, promotions management and innovative consumer services, as well as applications spanning the whole supply chain, such as product traceability (Pramatari et al. 2005). Despite the broad spectrum of applications, RFID implementations currently take place internally within a company, mainly with the objective to automate warehouse management processes or store operations in the first run. As an outlook to the future, a recent industry report (GCI 2005) identifies certain application areas (specifically store operations, distribution operations, direct-store-delivery, promotion/event
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execution, total inventory management and shrink management) as the major opportunities for the deployment of RFID technology in the short and mid-term. These application areas have been selected based on their performance versus the ratio of expected benefits over associated costs, including process transformation difficulties. The same report identifies further opportunities in several “track and trace” activities (such as anti-counterfeiting, product diversion, recalls/reverse logistics, fresh/code-dated product management, cold chain monitoring, and legal compliance), although it is noted that “more work is required to understand its potential applications and benefits in these areas” (GCI 2005). The ‘more work’ refers to the need to connect supply-chain partners and streamline the flow of information for the applications to operate.

In the various application areas, the contribution of RFID can be sought across the following axes:

a) the automation of existing processes, leading to time/cost savings and more efficient operations;
b) the enablement of new or transformed business processes and innovative consumer services, such as monitoring of product shelf availability or consumer self-check-out;
c) the improvement achieved in different dimensions of information quality, such as accuracy, timeliness etc. (Ballou et al. 1998);
d) the formation of new types of information, leading to a more precise representation of the physical environment, e.g. a product’s exact position in the store, a specific product’s production, distribution and sales history etc.

The last two axes in particular, ask for new decision support algorithms and tools for the associated benefits to be exploited, opening-up a whole new research area for decision support systems. Furthermore, for the full benefits to be ripped, the information needs not be exploited locally but be shared with supply chain partners in a complex network of relationships and decision making.

If RFID technology is only exploited internally by a network leader looking solely at internal benefits, e.g. a big retailer trying to improve store operations, then suppliers confront RFID technology as another unfortunate strategic necessity (Barua et al. 1997). This is already an existing trend in the market expected to have a negative impact on RFID market acceptance and adoption rates. Subramani (Subramani 2004) argues that
suppliers benefit from information technology (IT) use in supply chain re-
lationships when they use IT either in order to gain higher business-
process specificity or in order to gain higher domain-knowledge specificity. 
We could say the first two axes above are associated with business-process 
specificity while the latter two are associated with domain-knowledge 
specificity. Under this perspective, the question that arises is how to enable 
collaborative processes and decision making exploiting the aforementioned 
RFID capabilities, so that not only network leaders-retailers but also sup-
pliers can benefit from the employment of RFID both in improving process 
management and in gaining domain knowledge.

3. A proposed architecture for RFID-enabled collaboration 
and decision making in a networked business 
environment

In this section we describe a proposed architecture that can support new 
RFID-enabled decision-support and collaboration practices between sup-
ply-chain partners in a networked business environment. As a field case, 
we consider the grocery retail sector which is characterized by an intense 
supply-chain environment on one hand, handling thousands of products 
and supply-chain relationships on a daily basis, and increased competition 
and consumer demands on the other.

In this context, the key requirements that should be considered from a 
decision-support perspective include:

- the immense amount of data that need to be processed in real time; 
  already today that products are identified at product-type level 
  through barcodes, the handling of information in real-time for de-
  cision-support purposes is quite a technical challenge;
- the need to ensure synchronized product information between sup-
  ply chain partners (Roland-Berger 2003); although the sector has 
  adopted barcoding technology as a standard to identify products, 
  yet the information is maintained at different levels in either the 
  retailers’ or the manufacturers’ systems causing serious integrity 
  issues when data exchange and synchronization is required;
- the many different business relationships that need to be sup-
  ported; each retailer may collaborate with hundreds of suppliers 
  and vice versa;
the different collaboration scenarios that may be applicable in each supply-chain relationship; a retailer may collaborate with one supplier on efficient warehouse replenishment following CRP/VMI or on category management with another supplier etc. (Pramatari 2006);

the need to support seamless information sharing and collaborative decision-support through automated and secure interorganizational system links;

In order to cope with the above requirements, the proposed architecture employs:

a) data-stream management systems (DSMS), supporting real-time analytics and decision support based on continuous queries of transient data streams, and

b) Web Service orchestration, enabling secure and seamless information sharing and collaboration in a distributed environment.

Until recently, decision support systems (DSS) were based on data that were stored statically and persistently in a database, typically in a data warehouse. Complex queries and analyses were carried out upon this data to produce useful results for managers (Chatziantoniou 2003). In many applications however, it may not be possible to process queries within a database management system. These applications involve data items that arrive on-line from multiple sources in a continuous, rapid and time-varying fashion. This data may or may not be stored in a database.

For this reason, applications have recently been developed in which data is modelled not as persistent relations but rather as transient data streams. A good example of such an application would be one that constantly receives data about electronic product code observations across a chain. In data streams we usually have “continuous” queries rather than “one-time”. The answer to a continuous query is produced over time, reflecting the stream data seen so far. Computing real-time analytics (potentially complex) on top of data streams is an essential component of modern organizations (Chatziantoniou et al. 2005).

Being able to efficiently perform complex real-time analysis on top of streams of RFID measurements is the reason data-stream management systems (DSMS) are employed by the proposed architecture. This choice supports certain collaboration and decision support scenarios, as will be further described in the following section. In addition, a relational database
management system (DBMS) is used in order to support less information-intensive scenarios and other elements of the application.

As far as the interorganizational system links and collaborative supply chain processes are concerned, the technology of Web Services is employed in order to support them. A Web Service, as defined by the W3C Web Services Architecture Working Group, is “a software application identified by a URI, whose interfaces and bindings are capable of being defined, described, and discovered as XML artifacts. A web service supports direct interactions with other software agents using XML-based messages exchanged via Internet-based protocols” (W3C 2002). In general a Web Service is an application that provides a Web API, supporting application-to-application communication using XML and the Web.

Others refine this definition further by requiring the description be a Web Services Description Language (WSDL) document and the protocol be SOAP (Ferris et al. 2003). UDDI registries are further used to identify and locate web services.

To move beyond the "publish, discover, interact" model, it is required to have the ability to define logic over a set of service interactions. This not only enables the composition of a set of services, but it also enables the definition of the interaction protocol of a single service by specifying a sequence of its operations. The two prevalent standards - the Web Service Choreography Interface and Description Language (WSCI, WS-CDL) (Arkin et al. 2002) and Business Process Execution Language for Web Services (BPEL4WS) (Andrews et al. 2003) - are designed to reduce the inherent complexity of connecting Web Services together. The terms orchestration and choreography have been employed to describe this collaboration:

- **Orchestration** refers to an executable business process that may interact with both internal and external web services. Orchestration describes how Web Services can interact at the message level, including the business logic and execution order of the interactions. These interactions may span applications and/or organizations, and result in a long-lived, transactional process. With orchestration, the process is always controlled from the perspective of one of the business parties.

- **Choreography** is more collaborative in nature, where each party involved in the process describes the part they play in the interaction. Web Services choreography aims at the coordination of long-running interactions between distributed parties, which use Web
Services to expose their externally accessible operations (Muehlen et al. 2005).

The two notions, however, are not completely distinct. For instance, BPEL4WS can be used both to describe orchestration and choreography issues (Viroli 2004). Furthermore, Muehlen et al. (Muehlen et al. 2005) classify choreography standards proposals into two categories: REST-oriented and SOAP-oriented standards, which are not necessarily competing, as REST represents a navigational style of design and SOAP represents a procedural style. As we recognise that developments in this area have not yet converged into a single prevailing standard, in the proposed architecture we choose to use BPEL4WS and SOAP for implementing the notion of Web Services orchestration. However, the other standards could also have been used for this purpose.

Figure 10 gives a schematic representation of the proposed architecture. As we see on the figure, this is a distributed architecture, where the application layer runs on the system of each collaborating partner and Web Services are used as the interface between the different partners’ systems using SOAP requests and responses. The data layer is implemented by both a relational database system (DBMS) and a data stream management system (DSMS) providing the application with a continuous stream of EPC information. The central orchestration engine coordinates the exchange of messages between the Web Services following the logic of specific process scenarios. Finally, the Collaboration Registry is the implementation of a UDDI directory enhanced with additional higher-level information regarding a collaborative relationship, including which partner collaborates with each other under which process scenario and with what security privileges.
Because this architecture is meant to support collaborative processes and decision making in the grocery retailing/fast moving consumer goods sector, it is deemed necessary to interlink it to the GDSN and ONS/EPC Network infrastructures or similar infrastructures used for the same purpose. The Global Data Synchronization Network (GDSN), established by GS1 (www.gs1.org) and GCI (www.gci.org) aims at providing supply chain partners with accurate product catalogue information and is implemented through a collection of data pools and global registries. On the other hand, the EPC Network, supported by the Object Name Service (ONS) infrastructure, has started materializing under the administration and directives of EPCglobal (www.epcglobalinc.com) and with the support of global standardization bodies and leading industry forums (GS1, GCI) (Shih et al. 2005). The difference between the GDSN and the EPC Network is that the former is meant to support information sharing about product type (what is currently identified via a barcode) whereas the latter is meant to support information sharing about unique product instance (identified via an RFID tag, following the EPC standard) (EPCglobal 2004). The proposed architecture connects to either these two or similar directory services in order to get the master product information associated with a specific product type identified via a barcode (GDSN) (e.g. product name, manufacturer, weight, dimensions, etc.), or additional information associated with a specific product instance identified via an EPC (ONS/
EPC Network) (e.g. production date, distribution history, expiration date etc.).

From a functional perspective, the proposed architecture can support different collaborative processes and decision-support scenarios. Each of these scenarios can be supported by separate components at the application layer, as for example the following indicative interconnected modules:

- Store management module (SM)
- Promotion management module (PM)
- Product traceability and reverse logistics module (TRL)
- Inventory management and collaborative replenishment (ICR)
- Consumer information services (CIS)

Each of the SM, PM, TRL, ICR and CIS modules performs different functionality on each site; depending on what is the role of the collaborating partner, e.g. supplier, distribution centre, retail store. The functional decomposition of the application and the way it interacts with the rest of the elements in the architecture is schematically depicted in Figure 2 below.

![Figure 11: System Functional Decomposition](image)

As an example, the following figure presents an indicative scenario supporting dynamic pricing enabled by the “Promotion management module”, where the supplier collaborates with the retailer in order to reduce the price of some products approaching their expiration date.
4. Evaluating the business relevance of the proposed architecture and enabled scenarios

While with the development of the Internet, the centralized application architecture initially dominated the field of both Web-based Decision Support Systems (DSS) (Jichang et al. 2004); (Zhang et al. 2005) and collaborative supply chain management systems (Pramatari 2006), we would argue that a decentralized-application-architecture presents bigger advantages in the context presented in this paper. (Schuff et al. 2001) have analyzed the benefits of centralisation vs. decentralisation of application software. Based on their analysis we can conclude that in the specific context, the centralised software architecture is expected to lead to serious scalability issues and delays in system response, especially due to the exponential information increase associated with the employment of RFID for unique product identification and the need for real-time analytics and decision-support. Furthermore, a distributed-application-architecture allows for better integration of the application with internal business processes, as compared to the use of an external web-site (Pramatari 2006). Web Services further provide the means to enable this integration in a standard way (Sayah et al. 2005).

In that respect, the proposed system can be categorized as a distributed Web-based Decision Support System as described by (Zhang et al. 2005),
where the data and decision support tools from multidisciplinary areas can be located on computers distributed over a network. In such a distributed environment, a Web-based DSS needs a distributed framework to manage and integrate the data and tools in a seamless way. In the case described in this paper, this framework is provided by Web Services, the Web Service orchestration engine and the collaboration registry.

The proposed architecture is a generic distributed architecture that can potentially enable various supply chain collaboration and decision support scenarios, whether these are enabled by RFID technology or not. What is important to understand though is which of these scenarios make sense to implement from a business perspective.

The proposed architecture is employed in the course of the SMART research project, funded by the European Commission (IST-2005, FP6), with participating user companies being European grocery retailers and suppliers from the fast-moving consumer goods sector. Companies in the sector already have a more-than-ten-years collaboration history and some collaboration processes have become standard business practice across Europe, such as CRP/VMI employed in retail warehouse replenishment or Category Management dealing with the marketing aspects of managing product categories in the store (Pramatari 2006).

In order to understand the business relevance of alternative scenarios that can be supported by the proposed architecture, we conducted a field survey based on questionnaires addressed to top executives representing retailers and suppliers/manufacturers in the European food industry. According to (Hevner et al. 2004), examining the relevance of a solution is a fundamental step in the design approach of Information Systems research, and this has been the key motivation behind this field survey. The objective of the survey was two-fold: a) to understand the relevance of some new RFID-enabled processes to business executives and the degree these fit with their current strategies; and b) to examine the degree to which collaboration is a prerequisite in these processes. Furthermore, the survey provided useful input regarding the RFID readiness of companies and the degree they are already involved in supply chain collaboration activities.

The survey focused on the following eight alternative RFID-enabled collaboration scenarios:
1. *Back-room and shelf visibility*: The store personnel receive real time, information about the backroom inventory level of each product. If a
product is not on the shelf (Out-Of-Shelf-OOS), but there is available stock in the backroom, the store personnel is informed to refill the shelf; otherwise, if there is no stock in the store at all (Out-Of-Stock), a new replenishment order is placed. The salesman of direct-store-delivery suppliers has also direct access to this information through a PDA.

2. **Out-of-shelf response**: Retailer and supplier get statistical information about shelf availability, i.e. the level of stock on the store shelves, in order to monitor the level of out-of-shelf, which is considered one of the major problems the retail sector faces today (Roland-Berger 2003). While the previous scenario requires real-time information flows to support daily operations, this scenario is more about business intelligence and decision support.

3. **Remote shelf management**: Retailer and supplier get real-time information for the actual shelf layout. RFID readers “scan” and “read” the shelf and provide its “digital image”, including information about the size, specific products’ position and layout, as well as information about the shelf’s performance.

4. **Smart pricing**: Retailer and supplier have the possibility to identify products that are close to their expiration date or are standing still on the shelf for a long time and dynamically reduce their price, in order to boost consumer demand and reduce waste.

5. **Smart recall**: Retailer and supplier have the possibility to identify the location of products with specific characteristics and recall them from the market e.g. in case there is a risk with consumer safety, fast and at the minimum cost.

6. **In-store promotion management and promotion evaluation**: Customers get direct information about special offers and promotions relevant to the product they just got off the shelf. Retailer and supplier can manage better their promotion plans and evaluate in real-time the efficiency of their in-store promotion activities.

7. **Demand management**: Retailer and supplier have the possibility to monitor the inventory and the sales of products and relocate them if needed (e.g. in case of a special promotion event) in order to eliminate lost-sales opportunities.

8. **Traceability information**: The consumer at the end-point-of-sales has a clear view of the product’s history and origin. At special information desks, the consumer can get details about production date and origin, expiration dates and other unique product’s information that can ensure product authenticity and safety.
These are new scenarios that capitalize on RFID’s capabilities for automatic data capture and identification of unique product instances in combination with other information that can be derived in association with RFID, such as the shelf location, the context of an in-store promotion event etc. Some of the scenarios focus on the management of specific operations and processes (e.g. 1, 4, 5), others focus more on supporting decision-making and building domain-knowledge (e.g. 2, 3), and others combine both aspects (e.g. 6, 7, 8).

Based on the answers to the field survey (see Figure 4), it comes out that retailers and suppliers agree that ‘back-room and shelf visibility’ as well as ‘demand management’ are important possibilities that can contribute to their company’s strategies. However, suppliers seem to value more than retailers the possibility for promotion evaluation and promotion management while retailers are more interested in being able to locate and recall products from the stores.

![Figure 13: Field survey results: relevance of alternative scenarios](image)

When retailers and suppliers were asked to indicate the top three areas in which they need to work collaboratively with their supply-chain partners, most of them mentioned supply-chain cost reduction (which was placed among the top three areas by more than 50% of respondents), product safety and traceability and increasing shelf availability (see Figure 5). These answers reveal that the companies in the retail sector have already adopted a collaboration mentality and are willing to use infrastructures supporting collaborative processes and decision-support, as the one proposed in this paper.
5. Conclusions

Following developments in the RFID field and in supply chain collaboration, the paper proposes a distributed network architecture that can support new RFID-enabled collaboration and decision-support scenarios. The proposed architecture is based on the technology and notion of Web Service orchestration in order to enable interorganizational process links and seamless information flows, as well as on the technology of data stream management systems, in addition to relational database management systems, in order to manage the continuous stream of EPC information for decision support.

The proposed architecture can be categorized both as a Web-based Decision Support System that moves beyond the centralized web-site paradigm to a distributed one, and as a Supply-Chain Collaboration System. As such, it aims at supporting both internal operations of network leaders,
such as big retailers, but also suppliers who look into opportunities to benefit from the use of IT in supply chain relationships either by gaining process specificity or domain knowledge specificity (Subramani 2004).

Based on the results of a European field survey, the paper discusses the relevance of the proposed architecture and corresponding RFID-enabled collaboration and decision support scenarios to business executives of the grocery retail sector. The responses show that some scenarios are more appealing to retailers than to suppliers and vice versa, while there is a well-grounded belief shared by both retailers and suppliers that some processes should be done in collaboration.

Rather than evaluating the relevance of the proposed scenarios from a business perspective, what is even more important is to evaluate the degree to which the proposed architecture adequately supports the corresponding scenarios and fulfils the requirements from various perspectives, which is a clear next direction of research in this area. Other directions for future research relate to evaluating specific design alternatives, such as the use of different Web Service choreography standards rather than BPEL4WS, in the specific context as well as comparing the distributed architecture approach to a centralized architecture or to EDI which has traditionally been used to support supply chain collaboration (Pramatari 2006).

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23. Designing an Agent-Based Inter-Organizational Coordination System for Planning and Control of Container Barges in the Port of Rotterdam

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Abstract

One of the results of the ongoing globalization is a large increase in good flows around the world. The Port of Rotterdam handled 5.6 million containers in 2005. Most of these containers are shipped to the hinterland by truck, train or barge. Transporting containers requires a lot of coordination between different parties, and thus it comes, as a result, with a lot of communication and information exchange. In this paper we specifically look at the container barge sector, and the problems that exist in that domain to align barge visits with terminal capacity. Aim is to develop a system that enables terminals to achieve high quay utilization and that supports barges to leave the port according to their sailing schedule. In this paper we show the first results from the APPROACH2 project. First, we will discuss why an agent-based solution is a logical choice as a solution for such a business environment. Second, we show the actual complexity to provide such a solution; limited by constraints coming from the players in the business network, e.g., staying autonomous, not willing to share competitively sensitive information, opportunistic behavior, et cetera. Third, we discuss the design decisions to be taken in such a development trajectory, and fourth, we show a first solution and provide some numerical results to show that an agent-based solution, taking into account several design issues, can lead to plans that meet the objectives of the players involved. Finally, we draw some conclusions and show directions for further research.

Keywords APPROACH, Enabling Technology, Smart Business Networks, Agent Technology, Coordination
Introduction

One of the results of the ongoing globalization is a large increase in good flows around the world. The Port of Rotterdam handled 5.6 million containers in 2005. Most of these containers have to be shipped to the hinterland by truck, train or barge. Transporting containers requires a lot of coordination between different parties, and thus it comes, as a result, with a lot of communication and information exchange. In this paper we specifically look at the container barge sector, and the problems that exist in that domain to align barge visits with terminal capacity in such a manner that terminals can achieve high quay utilization and barges can leave the port according to their sailing schedule.

This coordination problem is rather complex. This is because every day about 75 barges visit the port, and each barge has to visit on average eight terminals. In total there are more than 35 terminals in the port. Many of these also handle sea going vessels and some are closed during the night, which limits the possibilities for barges to plan a rotation. Moreover, there is no contractual relationship between terminals and barges, which means that they cannot force each other to provide a certain service level. At the moment coordination is done by means of telephone, fax or e-mail. However, this takes too much time and due to changes and disturbances it is often not possible to execute a certain rotation or quay plan as it was planned to. Traditional centralized information systems did never gain ground, due to various reasons – competitive issues being one of the most important ones.

Back in 2001, network innovator INITI8 proposed to approach the barge-rotation planning problem from a decentralized perspective and started a research project to investigate the possibilities. The project titled APPROACH resulted in a software prototype and several publications (Melis et al., 2003; Connekt, 2003; Schut et al., 2004; Moonen et al., 2005). In the project a decentralized system architecture was developed with software agents exchanging a minimal amount of information between the partners. The decentralized system fits well to the current market structure and gives a solution to the problem that parties are willing to cooperate without giving up their autonomy. The research results were that compelling that INITI8 continued after the initial project ended by extending the prototype into a working system named SYNCHRON8. In 2005 a new research project was launched named APPROACH2, targeted at extending the APPROACH concepts: not just pre-planning of barge-arrivals 24h in advance, but being capable to re-plan and plan in real-time.
In this paper we show the first results from this APPROACH2 project. First, we will discuss why an agent-based solution is a logical choice as a solution for such a business environment. Second, we show the actual complexity to provide such a solution; limited by constraints coming from the players in the business network, e.g., staying autonomous, not willing to share competitively sensitive information, opportunistic behavior, et cetera. Third, we discuss the design decisions to be made in such a development trajectory, and fourth, we show a first solution and provide some numerical results to show that an agent-based solution, taking into account several design issues, can lead to plans that meet the objectives of the players involved. Finally, we draw some conclusions and show directions for further research.

**Methodology and Brief Outline of the Paper**

Design is not just a daily practice for professionals and engineers, but when properly done, it can be a strong research paradigm as well. Hevner (2004) illustrates the paradigm as following: “by creating new and innovative artifacts the design paradigm tries to extend the boundaries of current information systems”. Furthermore, design aims to bridge the relevance gap between theory and practice (Romme, 2003). Important herein is not just designing, but especially the understanding why certain things work or do not. In order to do so, we follow the complete regulative cycle after Van Strien (1975); which consists of five different steps; namely: (1) signalize, (2) analyze, (3) design, (4) try out, and (5) evaluate. For a proper testing one should not only test and benchmark against lab data, but also compare, try-out and intervene within a real-world setting (Van Aken, 2004), which we plan for a later stage (as concrete input for SYNCHRON8).

In our research we apply a design oriented methodology; in this paper we present part of our work on this. Like the design of any information system, the design of agent based systems goes through several phases (Luck et al., 2004) as Figure 1 illustrates. We structured this paper accordingly. First, we describe the business problem that has to be solved and the environment the solution is to be implemented in. The latter provides constraints for the design decisions we have to make. Second, we decide on which type of system is appropriate and specifically the choice between a centralized and a decentralized system. Third, before we start designing a solution we have to make several design choices. For example, can we use a monetary coordinating mechanism or not, will players accept a certain authority regulating everyone’s behavior or does the system has to be self-
regulating, can everyone implement its own agent or is everyone going to use the same 'intelligent' agents’, et cetera. After making these choices we can start to design the coordination mechanism and consider agent intelligence and algorithms. Furthermore we have to think about the technical issues like the platform the system is running on, the protocols agents use for communication et cetera. Please note that, although the scheme does not depict it as such, many of the more recent software development methodologies do not strictly follow this waterfall-model – in which analysis, design and implementation in this strict order are the only phases – but follow more round-trip engineering approaches: with repeating steps, and frequent feedback loops.

Figure 1 Basic steps in enterprise software designs; also structure of this chapter

Business Problem and the Implementation Environment

In this section we elaborate a bit on the business problem we consider and the environment the solution has to be implemented in. In the shaded box we denoted the project statement the APPROACH project started with:

The problem of (manual) barge-rotation planning in the Port of Rotterdam (= barges visiting several container terminals on a roundtrip through the port)

affects barge operators, terminal operators, Port of Rotterdam, carriers / feeders, shippers

the impact of which is an infeasible planning that results in numerous problems in the execution phase, such as: double-
bookings, late terminal arrivals, queuing; thus: non-optimal system behavior

A **successful solution** would be to deploy a collaborative agent-based planning system that is capable of producing feasible and acceptable results for all parties involved. This solution should include the pre-planning phase (24H in advance), the re-planning based on updated information (4H before planned arrival), and disturbances management (real-time, during execution).

The requirements we gathered for the APPROACH2 project came from different sources: An important input were the results from the first APPROACH project and the SYNCHRON8 experiences. Dedicated interviews and workshops with industry representatives were another source to gather industry requirements, and gain insight in the differences between barge-operators and terminal-operators. Not explicitly mentioned in this paper is the work we did on key performance indicators for the different parties involved: this gave us interesting insights in how responsibilities are divided over the chain, and how different parties react upon each other. These elements are important for an agent-based control system which is implemented in an inter-organizational setting.

### 3.1 Business problem

The manual planning of barge-rotations is very difficult as we will show in this section (see also Moonen et al. 2005). This is because of many factors which complicate the planning. These factors are among others:

- **Physical layout of the port.** The terminals are spread over the port, mainly in three different clusters: city, Botlek and Maasvlakte. Sailing from one end to the other takes a barge around three hours. This impacts the rotation planning.
- **Physical layout of container terminals.** Sea going vessels are handled at the same quay, and terminals generally also handle road and rail activities. Capacities and layout are restrictive for the quay planning.
Existing systems. Many systems are in use throughout the port among different parties. With some of these systems interfacing is needed.

Type of journeys. We distinguish three different types of journeys: Rhine, Antwerp and inland domestic journeys. The type of journey influences the rotation of a barge. E.g. Antwerp traffic visits only a limited amount of terminals, but tends to have large quantities. Rhine in contrary results in many visits, and inland domestic e.g. is served with smaller barges.

Three important decision moments throughout time: 24h, 4h and 0h before execution. The current practice shows a division in three important decision moments. 24h in advance (i.e. every day before a specific time) terminals have to announce the amount of shared lab labor they need for the next day. 4h prior to processing a barge has to announce which containers it has to load, to let the terminal be able to stack the containers timely at the quay. 0h the terminal makes some operational decisions, like which team is processing a specific barge.

Late orders / plan disturbances: late orders but also breakdowns, et cetera have a disturbing effect on planning and operations.

3.2 Implementation environment

Next to the above listed issues that complicate the business problem there are some issues to consider regarding the implementation environment. Several issues do play an important role:

Many different players with conflicting objectives. In the system different players are involved, like terminal operators and barge operators, which have different objectives. This means that the system must meet the objectives of both groups of players, which are conflicting to a certain extent.

Highly competitive environment. Barge operators compete with other barge operators and do not want to give their competitors a perfect view on their inside operations; and the same holds for terminal operators.

Strategic behavior. Currently strategic behavior worsens the way the current systems works. Especially barge operators try to increase their opportunity to be processed timely by exaggerating the time they need for processing of just ask for a limited amount of time, knowing that once they are processed the terminal will not send them away. Data analysis of execution data from PortInfolink’s BargePlanning and interviews revealed that strategic behavior takes place to a substantial extend.
Gain-sharing. Gain sharing and therewith proper performance measurement turns out to be very important, in order to get the system implemented and adopted. Gains should be measured for every player individually and for the system as a whole. If the system does not meet the expectations of a single player, this player has an incentive to quit, which is not desirable.

Yearly growth. The container market has been growing yearly over the past decade with double digits, and the same is foreseen for the near future.

It is hard to establish a trusted party that coordinates all the operations. Barge and terminal operators will not quickly accept an authority that is coordinating everyone’s actions, due to the fact that they want to stay autonomous and in control of their own operations. Moreover, registration of e.g. performances will be hard which complicates the task of a possible authority of trusted party.

**Type of System: Centralized or Decentralized**

The first inter-organization systems appeared in the late eighties, the beginning of the nineties. These systems were mainly based on EDI, had a point-to-point nature, and were rather inflexible. These systems were not able to support the communication in the port in a proper fashion. Although a second generation provided a central planning hub, it proved to be hard to establish a working system due to e.g. the different systems and procedures of all the players that had to connect to the hub. Two other drawbacks of the centralized system appeared to be: Firstly, it is difficult to encapsulate all the needed information that should be ideally needed for decision making – see also Sridharan (2005), and secondly optimization of such complex models needs a large amount of processing time – hence the fact that an optimization run of a deployed ERP system within a large company could easily take an entire night.

Considering the business problem with factors such as the implementation environment from the previous section it will be clear that a centralized planning system in which one central hub plans and coordinates all the activities of the terminals and barges will not be easy to achieve. Reasons are, among others, that players feel lack of control about their own operations; the central party probably makes decisions that are beneficial for one player but are costly for another one, which is hard to explain and also, how to share the gains obtained by the system? Lee et al. (2005) and Lu et al. (2006) research the critical success factors for inter-organizational system implementation, and independently of each other some to similar
Design Decisions

After making a choice for a centralized or decentralized system, we now have to make several design decisions as depicted in Figure 2. The busi-
ness environment leads to a certain logistical mechanism to solve the business problem. This can be an approach towards continuous planning, but also a real-time assignment approach which neglects any pre-planning. The agent societal structure corresponds to the type of agent environment to establish: are all agents in the system equal, or do we go for a layered hierarchical approach? The coordination mechanism is a related and important design decision: how do agents synchronize their plans, agree about decisions, and monitor their performance. Human involvement in the system is another important design factor: who does what, how do system and user interact, and what is autonomously performed (by the system) and what not? Agent intelligence is also important to take into account: can the system learn, and analyze data, or should it just do its tasks as it is designed at design time. The last concrete step in the model as we present here is the technology choice: which should be the result of the previous steps, but often is a choice which is given by the experience of the designers and programmers involved.

![Design Decisions for agent based logistical decision support systems](image)

**Figure 2** An example of some of the specific design decisions to be made for agent based system design

The next section gives an overview of the first efforts to construct a prototype system for the barge rotation planning problem, continuing where APPROACH stopped, and taking the above design decisions into account.
The First Design for APPROACH2

In this section we make a first design of an agent system from a mainly logistical perspective. The question we consider is whether a distributed system is able to realize a kind of optimization in the business problem we consider. We therefore have to define agents, design a communication mechanism and to equip agent with some form of intelligence. Based on these results we can evaluate whether and when it is beneficial for terminal and barge operators to participate in the system and how the system performs over time. We first describe which entities are modeled in the agent system and how the communication among the agents can take place.

6.1 The Agents

The entities we concentrate on in this section are depicted in the entity relation diagram (ERD) of Figure 3.

Figure 3 ERD of the main entities in the container handling process

In Figure 3 the lines describe the relationship between the entities, e.g. a terminal negotiates with a barge about a convenient time for loading and unloading. This ERD serves as basis for the agent model we propose. To define agents we have chosen for a physical decomposition of the system since this comes most close to the current situation. This means that every barge operator and every terminal operator is equipped with an agent operating in their best interest.

To simplify our design, we made the choice to establish a system with two different types of agents: barge operator agents, and terminal operator agents. We assume here that all barge operator agents are equal and the same holds for all terminal operators agent. So, every barge operator agent would make the same decision if it would be in the same situation as an
arbitrary other barge operator agent. We focus on the question how to create intelligence for these agents such that both individual and mutual benefits can be achieved.

Before developing intelligence for agents we first have to define the goals of each agent. To find out the goals of both terminal and barge operators we did interviews which resulted in a complicated web of performance indicators that were considered to be important. To simplify the analysis we first focus on the main goal of both the terminal and the barge operator, leaving apart all the secondary objectives. The main goal of the terminal operator is its utilization degree. The main goal of the barge operator is to leave the port within the time window that is set in its sailing schedule – in which the barge needs to visit the different terminals, and load and unload its containers. Although this simplifies the situation, it is complicated again by the fact that a terminal operator decides only once a day on the amount of capacity it is going to operate the next day. For simplicity we first assume that the capacity of a terminal is constant.

One might wonder whether the simplified problem setting (with a single objective for all terminal and barge operators) is still realistic. Obviously the reality is far more complicated than the model we now consider. However, we are firstly mainly interested in the question whether and to which extent a distributed approach for this business environment can lead to optimization of the terminal and barge performance. Once we know this we can start thinking about adding complexity to the model, like more specific objectives of the agents or disturbances. The model we now consider is not restrictive if we would extent it to a more realistic setting in the future.

6.2 Coordination Mechanisms

6.2.1 General communication mechanism

The communication mechanism is very important for the way agent intelligence is developed. Agents can communicate directly (negotiation), or indirectly by means of the contract net protocol. The latter requires however a kind of (virtual) currency that is exchanged between parties, which is strange to the current situation since there are no contractual relationships between terminals and barges. We propose a direct communication mechanism (negotiation) which mirrors daily practice and is probably easier accepted by barge and terminal operators. Direct communication means that every barge operator contacts all the terminal operators it has to visit during its rotation about convenient times to load and unload. Based on the reactions of every terminal operator it decides when it is going to visit
every terminal and in which sequence. This is actually the way the manual
system works at the moment.

To illustrate the proposed agent model we depicted one barge operator
contacting several terminal operators to come to an agreement about the
time it can be handled – see Figure 4.

It can be necessary for a barge to cancel terminal visits if it becomes
clear during operation that appointments cannot be met due to distur-
bances. This is especially important when terminals refuse to process a
barge if it arrives too late. If a terminal refuses to process a barge, this
barge has to make new appointments. This probably means a delayed rota-
tion since it is likely that a terminal has no free capacity in the first couple
of hours. A barge would therefore try to make robust rotation plans which
are less sensitive for disruptions like delayed processing or sailing times.

Figure 4 Illustration of the working of the agent model

6.2.2 Analysis of possible implementations of the communication mecha-
nism

The choice for a suitable communication mechanism is not trivial. One can
think of several possibilities besides the way it is done currently. We first
discuss these possibilities and then propose a mechanism that might be
very useful.

First the way communication is done in the APPROACH1 case. In
APPROACH1 agents have to communicate relatively much to come to an
agreement, though communication can be done very fast. Every request
however, has to be processed by both the Barge Operator Agent (BOA)
and the Terminal Operator Agent (TOA). Moreover, for a BOA it becomes
more difficult to optimize it rotation, since it does not know what the possibilities are. The TOA conversely has only limited possibilities to plan a barge visit at the time it prefers.

The second possibility would be, just to plan a rotation and then ask terminals successively for the first opportunity to be processed. In that case a rotation is only based on travel times. However, the time a barge is in the port does not only depend on the travel times but also on the waiting times at every terminal. A BOA is willing to accept a bit more traveling if this leads to a reduction of the rotation time and as long it is profitable. In this way of communicating a BOA is not able to weigh travel and waiting times such that its rotation time is minimized. Although the TOA has more opportunities to process a barge at the preferred time, the result can be very negative for the barge.

The third possibility is not to ask for one feasible time slot, but to ask for a number of time slots instead. This means that a TOA provides a BOA all the time slots available for this barge. Based on the provided time slots a BOA optimizes its rotation and confirms the times it likes to visit the terminal. However, providing time slots has some important limitations. Firstly, it can happen that a barge cannot find a feasible rotation and has to ask for new time slots. The question is then whether terminals are able to provide other time slots. Secondly, a TOA has to block time slots that are provided to a certain BOA to prevent double bookings. Depending on the time needed to make a rotation, another BOA has to wait to get its time slots. In case of waiting a dead-lock can occur when two BOA’s are waiting on each other at different terminals. Thirdly, if a BOA confirms a certain time slot, the other slots are free again for other BOA’s. Other BOA’s (planning their rotation) have to be informed about that, which makes the system very complicated.

6.2.3 A two stage approach using waiting times

To overcome these limitations we propose a two stage approach based on waiting times. In the first stage a Barge Operator Agent (BOA) asks a terminal for the expected waiting times during a day and the terminal replies to this BOA with a waiting profile. This waiting profile shows the expected waiting time during the day and can be customized for a specific BOA based on its characteristics or its reputation. The expected waiting time is a maximum waiting time as well. This is a service to barges so that they have more certainty about the time their processing is finished. The barge has to make sure to be at the terminal at the time it promises to be. If it does not arrive in time, its reservation is cancelled and a new appointment has to be made. Waiting times have an additional advantage since they give possibilities for a Terminal Operator Agent (TOA) to keep some
slack in its schedule to cope with uncertainties. In fact, exchanging waiting times is more general than exchanging time slots since the latter can be derived from the former – although when moving towards an implementation in practice one should carefully consider how to implement and market this.

The second stage consists of constructing of a rotation and making appointments with the terminals. The rotation is constructed based on the waiting profiles and the expected waiting times. A BOA aims to find a rotation that the sum of the expected waiting, handling and sailing times. Once a BOA has determined the best rotation it announces the time it expects to arrive at every terminal and it receives a maximum waiting time in turn. A barge obliges itself to be at the terminal at the announced time. If not, it has to make a new appointment and its reputation at this terminal can get hurt. This reputation can be used in future models to adapt waiting profiles and to force barges to incorporate enough slack in their rotation to keep it feasible. This aspect results in a kind of self-regulation in the system, i.e., barges cannot deviate too much from their appointments although this behavior is not contractually enforced.

6.3 From Static to Real-Time Planning

Another important decision before developing an agent system is whether or not plans are made on-line (in real-time) or off-line (e.g. 24h in advance). In the latter case the request of all barges have to be submitted to the system at e.g. 10:00 every day to make a plan for the next day. This is e.g. done in the APPROACH1 implementation. This has some disadvantages however, because plans need to be revised probably when disruptions occur and rotations become infeasible. On-line planning in contrary is more flexible since plans are constructed and adapted during the day.

In this paper we implement a more real-time planning system, or to be more specifically, a dynamic-deterministic planning system. Dynamic means (compared to static) that barge requests arrive during the day. Deterministic (compared to stochastic) means that there is no uncertainty in sailing times and handling times, and that there are no disturbances during operations.

We like to mention that if we would make the step from a deterministic to a stochastic model, this would have an impact on the performance indicator of the system as a whole and of the players in particular. Then, not only the performance in terms of utilization or rotation time becomes important, but also the probability that a rotation or a quay schedule can be executed considering disturbances that possibly happen. This means that besides performance of a schedule also the robustness of a schedule is im-
portant. A robust schedule is usually defined as a schedule that remains of high quality when the environment deviates from what was initially projected (Leus, 2003). This means that some uncertainty in the execution is taken into account.

In contrary to the Approach1 implementation of an agent system which focused on creating feasible plans, we focus on creating optimal plans as well. In an agent based solution this is a difficult concept, since every player has its own interests and one single objective is hard to define. The problem is that interests can conflict and have to be weighed carefully to find a solution. In this paper measure the performance of the algorithms by looking at the objective of the barge, i.e., looking at the barge that is delayed the most. The objective of the terminal (maximize utilization) is not relevant here, since we assume a fixed amount of capacity and that all barges have to be processed.

6.4 Experimental Design

In this section we set our experiments. First we show some results from experiments done in September 2004 showing the problems in the current situation. Then we describe two dynamic algorithms and one deterministic-static algorithm. The latter we use to compare the performance of the dynamic algorithms. We would like to mention that the algorithms are a first design. Further research is needed to make them more sophisticated and fitted to the problem at hand.

6.4.1 Current situation

The way barge rotations and terminal capacity are currently aligned does not only lead to inefficiencies but even to infeasible rotations or quay plans. This is clearly illustrated in a workshop with barge and terminal operators held in September 2004. More details about the workshop and the results can be found in Moonen et al. (2005). In the workshop barge and terminal operators had to align barge rotations and terminal capacity on the way they were used to do it. Afterwards the results were compared with an agent implementation of the system. The goal of the workshop was to clearly show barge and terminal operators the problems in the current situation and the great potential of an agent based solution. The focus was mainly on creating feasible plans, which would mean a big improvement compared to the current situation.

The results of the workshop indeed indicated that, although barge and terminal operators tried their best, they could not even come up with feasible plans. Some barges had to visit two or three terminals at the same time. The agent-based implementation in contrary was able to provide feasible
plans in reasonable time. The impact of infeasible plans is great, since infeasibilities lead to unused capacity and a rapid propagation of this inefficiency to other terminals. Once rotations or quay plans become infeasible, barge and terminal operators easier decide to deviate from their plans thus worsening the situation.

6.4.2 Setup of experiments

To illustrate the performance of an agent based system we show some results based on the dataset used in the workshop. This gives us the opportunity to make a comparison with a “real situation”. Comparison based on real data is hard for several reasons. Firstly, we need more than one case to make the conclusions statistically significant. Secondly, it is not possible at the moment to collect for one (let alone for more than one) case all the relevant data necessary for a comparison. Thirdly, making a comparison between the plans made in practice and the plans that are made by the agent system is not possible since most of the plans made in practice are infeasible.

We simulate two different dynamic-deterministic algorithms. In the first algorithm barges optimize their rotations bases solely on travel times. After they have determined the shortest path to travel to the port, they ask the terminals successively for the first possible processing time. So, barges do not consider waiting times to optimize their rotation. We refer to this algorithm as the ‘first dynamic model’.

The second algorithm is based on the two stage approach described in the previous section. Barges arrive one by one at the entrance of the port (Brienenoord) and plan their rotation based on travel times and expected waiting times. To this algorithm we refer as the ‘second dynamic model’.

Both dynamic algorithms (which are described more extensively in the next sections) we compare with a traditional (not agent-based) algorithm which is static and deterministic, i.e., it knows everything in advance with certainty. The static-deterministic algorithm plans all barge rotations with the objective to minimize the maximum lateness, i.e., to minimize the delay of the barge that is delayed the most. Delay can also be negative, when all barges can leave the port in time. In the next section we describe this algorithm. We refer to this algorithm as the deterministic benchmark.

The setting used in the workshop was as follows. In total 22 rotations had to be planned along eight different terminals in a period of 24 hours. A rotation consists of at least four and at maximum eight terminal visits. Sailing times are calculated based on an average sailing speed of 15 km/h and the real sailing distance between terminals. Handling times are equal to the
average time to handle a container in practice. For every rotation the expected time of arrival, the expected time of departure, the number of terminal visits and the number of containers to load and unload per terminal are given.

6.4.3 First dynamic model
The first dynamic model is rather simple and works as follows. Every Barge Operator Agent (BOA) determines a sequence of terminal visits that minimizes the travel time through the port. We use a nearest neighbor heuristic to construct and k-opt to optimize the sequence (for further reading we refer to e.g. Michalewicz (2004)). Based on this sequence it calculates the times it can arrive at the first terminal and asks the terminal whether it can visit at that time. The Terminal Operator Agent (TOA) returns the first possible time after the requested time. Based on this time the BOA calculates the time it can arrive at the second terminal and asks whether it can be processed at that time. The TOA of the second terminal again returns the first possible time. This process continues until all terminals are planned. It can happen that the rotation is longer than the planned stay in the port.

6.4.4 Second dynamic model
The second dynamic model is based on the two-stage approach described in one of the previous sections. In the first stage terminals provide a barge a waiting profile, indicating the maximum waiting time at every moment of the day. The waiting profile is calculated based on available time slots. To determine available time slots the terminal has to take planned sea vessels, barges and closing times into account. However, the calculation of available time slots is a bit more complicated, since all the planned barges agreed on a maximum waiting time after their expected arrival time. Consider the request of one specific barge. To find all the time slots in the current schedule a terminal operator has to evaluate for every point at which the barge can be inserted in the current schedule what the earliest and latest possible starting time is. It can calculate this to plan all barges scheduled before the time slot we consider at their earliest starting time, and all barges after the time slot we consider at their latest starting time. The terminal operator evaluates this for all possible time slots, i.e., for all possible points at which the barge can be inserted in the current schedule.

Once a terminal has determined all available time slots it calculates for discrete moments in time (e.g. every 15 minutes) the expected waiting time for the next available time slot. After calculating all the maximum waiting times for the whole planning horizon, the terminal increases all the waiting
times with a certain amount of ‘minimal waiting time’. This means that a barge calling for processing within an available time slot, still faces some waiting time. This minimal waiting time gives the terminal the opportunity to change the starting time of the barge to be more flexible toward future barges.

The rotation of the barge is calculated using a traveling salesman heuristic, minimizing the sum of the sailing, handling and waiting times. We use a nearest neighbor heuristic to create a rotation and apply k-opt to improve the rotation.

6.5 Deterministic Benchmark

The static algorithm, we use to compare the dynamic algorithm, uses the Resource Constrained Project Scheduling Problem (RCPSP; see, for example, Demeulemeester and Herroelen (1992)) as a base model. In the classical RCPSP, a single project, consisting of a number of activities, has to be scheduled. To process the activities, a number of resources are available. Each resource consists of a number of parallel processors. Each activity requires during its processing a number of units of each resources (for example, 2 units from Resource 1 and 5 units of Resource 2). Between activities, precedence relations exist. An activity cannot start before all its predecessors are finished.

![Figure 5 Example of an activity-on-node network](image)

For solving the RCPSP, a graph representation is widely used in the literature. This graph representation is known as an ‘activity-on-node network’. See Figure 5 for the activity-on-node network for a simple project, consisting of three activities, which all have a node in the graph. There are precedence relations between Activity 1 and Activity 3, and between Activity 2 and Activity 3. This means that Activity 3 can only start when both Activity 1 and Activity 2 are finished. Besides the nodes representing an activity, there are two dummy nodes s and t. Dummy node s represents the project start and dummy node t represents the project end. If we give each
node a weight that is equal to the required processing time, then the length of a longest path from s to a node i is equal to the earliest possible starting time of Activity i. The length of a longest path from s to t is then equal to the earliest possible completion time for the project.

We represent the terminals by resources in the RCPSP. The number of processors for each resource is equal to the number of quays of the associated terminal. In this way, we model that a terminal can handle two barges at the same time if it has two quays. Each terminal visit of a barge is represented as an activity. The processing time of an activity is equal to the load and unload time of the associated terminal visit.

We need to change the properties of the activity-on-node network in a number of ways to deal with characteristics that are not modelled in the basic RCPSP. For example, we give an arc from s to a node a weight that is equal to the arrival time of the associated barge in the port. In this way, the earliest possible starting time of this activity is at least equal to this arrival time. Moreover, we give an arc between two nodes (representing terminal visits of the same barge) a weight that is equal to the sailing time from the first terminal to the second.

For finding a barge rotation, the first terminal to be visited is fixed, whereas the remaining terminals to be visited can be visited in any order. To handle this in our model, we introduce a fictive resource for each barge with only one processor. Each activity associated with a barge requires, beside the terminal resource, this fictive resource. Since this fictive resource has only one processor, the activities associated with the terminal visits of a barge, have to be sequenced. In other words, in a feasible schedule, no two activities from a barge can be processed in parallel.

Finally by having a resource profile, in which the number of available processors for a resource may vary over time, we are able to deal with terminals that are not available at certain moments in time. This is required for terminals that are not open 24 hours a day and for dealing with reservations for sea vessels, which have priority in planning over the barges.

To solve the resulting problems, we used an algorithm that is based on the adaptive search algorithm by Kolish and Drexl (1996). In this algorithm, a (large) number of schedules is generated based on randomized priority rule scheduling. For the basic RCPSP, this algorithm finds schedules that are close to optimal very fast. We adapt this algorithm, for example, to deal with the resource profiles, which are not present in the basic RCPSP.

6.6 Numerical Results
The results obtained by the algorithms from the previous section are preliminary results. Further research is needed to extend and fine-tune the algorithms and make them more fit to the problem at hand.

We only considered the dataset of the workshop, so we cannot draw generic conclusions about the results we get. Looking at Table 1 it is clear however, that a dynamic model based on waiting times and travel times in this case results in a much better performance, than the dynamic model which only uses travel times to plan a rotation. The solution provided by the deterministic benchmark is optimal in terms of the objective and was obtained within one minute.

In Table 1 we can see that increasing the minimum waiting time to one hour (i.e. minimum amount of maximum waiting time) has a negative effect of the average and maximum lateness of the barges. This is because every barge reckons with the worst case, i.e., the maximum waiting time at every terminal. It is quite well possible that the barge indeed has to wait the maximum waiting time if the terminal plans another barge before him (which it cannot know). This means that barges plan their rotation such that all appointments with terminals can surely be met. This leads directly to an increase of the rotation.

<table>
<thead>
<tr>
<th>Model</th>
<th>Maximum Lateness</th>
<th>Average Lateness</th>
<th>No barges delayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic benchmark</td>
<td>-24 min.</td>
<td>-680 min.</td>
<td>0</td>
</tr>
<tr>
<td>Dynamic model 1</td>
<td>696 min.</td>
<td>-276 min.</td>
<td>8</td>
</tr>
<tr>
<td>Dynamic model 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 Results from three different models

If waiting times are high at terminals, it can perhaps become beneficial for barges not use the worst case (the maximum waiting), but a fraction of the waiting time. If a barge notices during operations that appointments with terminals later in its schedule cannot be met, it cancels these appointments and makes new ones. However, terminals are probably highly utilized in the first couple of hours, which can mean the barge has to wait several hours for a new time slot. This can mean that revising a rotation
during operations can be less attractive than using the worst case scenario, i.e., the maximum waiting times at terminals.

One can see that in this case it is better to have a minimum waiting time greater than zero. This is what we would expect as well. The reason is that terminals have more freedom to use their idle time (they can move the starting times of barges). This is beneficial for the terminal and for the barge as well, since it becomes more likely that a barge can be processed earlier. A minimum waiting time of zero means that a barge can have a maximum waiting time of zero when it calls for processing in an available time window. This can be negative however for the terminal, since the possibilities to fill remaining idle time become very limited which has a negative effect for future barges as well (a terminal is not able to increase its gaps a little bit). We expect that the amount of minimum waiting time depends on the utilization of the terminals. If terminals are highly utilized it is probably better to have more minimum waiting time, whereas in less occupied times a minimum waiting time of e.g. zero can be sufficient.

Discussion

This paper discussed the design process and decisions to be made for the design of an agent based planning and coordination system for the particular case of barge rotation planning in the Port of Rotterdam; research which took place within the APPROACH2 research project. The case handles about the planning barge rotations: barges sail through the port, and have to load and unload containers at different terminals – the amount of barges sailing the port each day, combined with the plan-interrelationships of visits, makes it an immense inter-organizational planning and scheduling problem. Barge rotation planning is complicated for several reasons; the complex network of different competing parties that heavily influence each other being one of these. Manually coordinating such planning turned out to be very hard. A system to automatically support these coordination decisions is therefore necessary. Establishing an inter-organizational planning system is complicated by the fact that the vast amount of different players have different, and partially also conflicting, objectives and interests. Container terminals compete with each other, and the same holds for barge operators. Cooperation and in particular the coordination of activities can deliver them a win-win – which we earlier found and presented in Moonen et al. (2005) – however, establishing this is neither easy nor straightforward. It turned out that many parties do not want to hand over autonomy to a centralized system their competitors are also using; whereas centralized systems are hindered by the ability to react in real-time to local
disturbances – which is often the case in complex business networks such as the domain of (container) barge rotation planning.

The main design challenge was thus to develop a system that is beneficial for every individual player and supports the coordination of activities. Difficult issues that have to be addressed are the demands of the players to stay autonomous, not to share competition sensitive information and to be able to optimize their own operations at least to the same extent they can do now. This particular case seemed to be an ideal example for an agent-based system design (Wooldridge, 1995). In order to design a system for this, we followed several steps (see Figures 1 and 2); and although influenced by regular software engineering practices, we specifically consider the elements that set agent-based systems apart. The design follows a plain waterfall methodology: going from analysis, to design, to implementation, but the specific design decisions focus on agent construction: what logistical mechanism to use, how should the agent societal structure look-a-like, what coordination mechanism to use, what would be the role of human involvement in the system, how to cope with and integrate agent intelligence, and what specific technology platform and standards to use? By making these decisions explicit, one becomes aware of the elements that can be varied.

We present a first model in which we propose a communication mechanism which addresses a lot of issues from the business and implementation environment and enables both barges and terminals to realize their objectives. We stress that the choice of the communication is not solely a logistical decision, which means, only on the extent to which logistical improvements can be realized. It depends instead on the demands of the players like the extent to which competition sensitive information is shared, players stay autonomous, self-regulation is supported and whether gain-sharing has to be addressed as separate issue.

The experiments we performed show that a communication mechanism based on waiting times (besides travel times) is able to realize a solution that is close to optimal for the specific data set we considered, where practitioners where not able to find a feasible solution. The results also indicate that the extent to which a single player can realize its objective (e.g. high quay utilization) depends on the actions of other players and cannot be influenced. Consider for example two barges A and B and suppose the terminal is indifferent about which barge to process first in terms of quay utilization. For the barge however, it can make a major difference whether it has to wait or not for another barge. The terminal is not aware of the implications for the barges and can therefore hardly support it. Moreover it is not its business. So, the performance of a multi-actor decision support sys-
tem will probably be less than optimal because of these effects that are inherent to the problem we consider and the choice to design a decentralized system with multiple players having different interests.

Alternative ways to model a multi-player decision support system can be based on e.g. a monetary communication mechanism or on other agent societal structures; such as supervisor or coordinating agents. Please note that the monetary communication mechanism introduces the problem of gain-sharing and the control of the virtual money that is used, where in practice no contractual relationships exist between the players. A problem with additional agent roles in the agent-society can results in an implementation problem if players cannot recognize themselves in the system and feel to be not in control of their own operations. For the near future we therefore see a lot of research directions.

Firstly, more extensive simulations to evaluate the performance of the proposed communication mechanism, the design of more sophisticated barge and terminal algorithms and the extension to more realistic settings like the disturbances. Simulation with real-world data is an instrument that we perceive as very valuable in this respect. Currently a first spin-off from the APPROACH 1 project, called SYNCHRON8, is implemented by INITI8 in the port of Rotterdam. We hope to report soon on results from this project.

In a world where the nature of enterprise systems seems to move from batch wise planning towards real-time planning, and the focus shifts from intra-organizational towards inter-organizational, agent based systems should be seriously considered. Agent-based systems are different; foremost for the reason that they rely on (real-time) communication to derive to solutions, other than optimization models with a limited scope. In stead of monolithic systems, agents are small entities build for specific tasks, observing their environment and deriving to solutions through communication and negotiation. The current industry trend of service oriented architectures is partly inline with the ideas from the agent community: it is the idea to clue together new applications by connecting existing building blocks, and add a certain amount of intelligence in there. Learning and artificial intelligence are crucial elements for future generations of systems and instruments to bring in the needed flexibility and adaptiveness they need. Note however, that in order to address real critical exceptions that are not yet fully understood by an automated system, intervention of human planners, who are supported by up-to-date system information can be of crucial importance – see also Nissen et al. (2006).
Acknowledgements This work is partly performed within the DIPLOMA research project, which is one of the current research projects within the TRANSUMO research program. APPROACH2 is a case within DIPLOMA. For this particular paper we are very grateful for the contributions of Niels Lang, Laurent van Groningen, Ian Miller, and Peter Schuur. Please note that we intend to publish a further developed version of this article in a journal; contact the authors for specifics.

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Variety was the first word coming to my mind when I was asked to report about the different papers presented in subsession D. Not only variety in content, but also variety in research methods, in practical implications and writing and presentation style. However, there were not solely differences, the papers also had many things in common: all papers have a practical component and an industrial application, furthermore they all do relate to the topic of the event, since they all speak about smart ways of integrating networks, novel ways of streamlining existing processes, and innovative previously non-existing new practices. Last but not least, this session was probably not by accident subsession D; this D clearly links with the DESIGN focus all papers in this session had.

Peter Rittgen was the first to present about “Designing and Implementing Contracts for Smart Business Networks”. The focus was on the important role of contracts for smart business networking. The paper suggests an architecture that proposes a contract as the principal means of coordination, and describes ways on how such a contract can be derived and enacted through systems. The article is firmly grounded in literature, with a special focus on coordination literature, specifically agency theory and transaction cost economics. The paper makes a translation from this theory into a software system architecture that encapsulates the contract negotiation phase (which is a human thing) to the contract enactment phase, which is enabled through workflow management software functionality. Discussion focused on the generalizability of the architecture, and the need for re-negotiation of contracts when situations change.

The second presentation came from Katerina Pramatari. Katerina was not present in Putten, and presented to us through a video-enabled Skype. Her slides were presented on a second screen. Katerina talked about her paper titled “Intelligent Integration of Supply Chain Processes based on Unique Product Identification in a Networked Business Environment”, which was basically a talk about RFID technologies and their utilization within supply chains / networks. She started with a nice overview of earlier work done in this field, showed the importance of unique identification technologies throughout today’s enterprises and gave an overview where RFID can deliver a true contribution. Furthermore she described the role of webservice orchestration technologies, functional descriptions, and pointed specifically at the importance of evaluation for business relevance. She
concluded with an example on how unique ID technologies can be used in dynamic pricing. The presentation gave food for several interesting questions regarding security issues of RFID technologies, cost-benefit analysis, and the different type of inter-organizational collaboration scenarios.

Following this Skype enabled session, Hans Moonen and Albert Douma gave a (short) duo presentation on a “APPROACH2: The Real Smart Business Network, or How Agent Technology Improves the Coordination of Container Barges”. Their presentation gave an overview of the research going on in the APPROACH2 project: which is a project focused on the design and implementation of a software system that facilitates the planning and scheduling of barge rotations in the Port of Rotterdam; Europe’s largest port. Hans kicked off by presenting the business case, and type of research that goes on within the project. He furthermore made clear why the choice was made to go for a decentralized agent-based system, and showed the different process steps one has to go through when building inter-organizational agent-based systems. Albert then continued by illustrating the first steps the consortium made in designing, prototyping and testing/evaluating their first designs. Their approach is focused towards establishing real-time inter-organizational systems; which is interesting, through a compelling journey. The presentation thus raised more questions than it answered. “Which point-of-view are you designing the system from?, the barges, or the terminals” was one of the questions raised. Other issues discussed included the simplification and generalization of the problem into the simulation, and the question on how to deal with exceptions.

Joris Hulstijn was the last to present. He presented the paper “Towards Control Patterns for Smart Business Networks”. Again, an application oriented paper, bringing together governance & control mechanisms and software development, which results in control pattern development. The paper takes an economic value perspective, and proposes to utilize the e³-value methodology as a basis for the e³-control methodology. Next, the paper gives an overview of relevant literature related to control theory, conceptual modeling, and control patterns. This all results in a software design and the design of control libraries. The paper as well as presentation conclude with a case study: the testing of the developed methodology in the so called beer living lab – which illustrates the flow of information and decisions between trading partners and customs branches in different countries. After the presentation, several questions were raised, e.g. on the scalability of this solution (or is it too modeling-intensive?), and there was discussion whether e³ was the best starting point to start from. Joris had good responses to these questions, and promised, just like the earlier presenters to take all comments into account when working on the final chapters.
Looking back at the presentations, and looking again at the submitted papers, I think that we had a rather diverse collection of papers, that nevertheless had several things in common. They were all focused on industrial application of smart business networking, and all started from an identified concrete gap in today’s enterprise(s) systems. Each and every paper lists the existing literature and makes a clear business case to demonstrate the new solution. Having presented a paper following a design-methodology myself, I think we got an interesting glance of the different DESIGN efforts currently going on among smart business network researchers. A vastly developing domain such as smart business networks is, needs design as an essential element to help the field forward. Therefore, I wish each and all of you a happy reading, and hope that this might be an inspiration for your own work…
24. Coordinating and boundary spanning roles of business networks

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Abstract

The introduction of any innovation or ICT-artefact to an organization requires that the roles of innovators are represented during the process of innovation adoption, deployment and implementation. The roles of innovator, project leader, sponsor, gatekeeper and implementer are well known since fifty years back, but their importance in the introduction of recent smart ICT-enabled networks is little researched.

In this article we analyse three cases of attempts to launch ICT-enabled smart network. We describe the cases and the topology of each network. The key questions are whether all the roles are necessary, and the number of innovators multiplied on a network, or are there alternative ways of cooordination.

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Introduction

The transformation to digital economy is commonly linked with the advancement of strategic networks. Most often these business networks are formed in order to make existing production networks or supply chains more efficient (van de Ven, 1976). It seems that when the technological complexity of the product or service increases, companies more often prefer co-operation instead of mergers and acquisitions. For instance, Powell (1990) and Hagedoorn & Duysters (2002) have suggested that these kinds of flexible forms of organizations are appropriate because new knowledge expires quickly and requires timely learning. They can also adapt more easily to changes under uncertainty. In place of coordination through prices or authority, the networks rely more on relational communication, free will and trust. (Powell, 1990; Tsupari et al., 2001; Beugelsdijk, 2003).

Various kinds of networks in business have become more and more common—especially in societies of homogeneous background and institutional contexts with a sense of general reciprocity (Powell, 1990). For example Tsupari et al. (2004) show in their study that already over 80% of companies in manufacturing industry in Finland are involved in networks to some extent. The forms of co-operative relationship vary from single business transactions and long lasting commitments, annual contracts or projects to strategic partnership. The tendency seems to be a move towards partnerships requiring higher levels of commitment and higher coverage of firms’ operations (see figure 1 on the empirical results of the evolution of manufacturing networks in Finland).

This tendency clearly goes hand in hand with the trend of outsourcing. The companies are focusing on core activities and outsourcing some parts of organizational functions. This automatically means increased number of partners and vendors with whom the company has to coordinate its actions. Yet most companies must constantly improve their processes and products, which mean that also the innovating activities reach beyond organizational boundaries.
These boundaries are vital for the companies’ resource expansion and knowledge acquisition e.g. of each others’ cultures and procedures. We see the coordination of these interfaces at the heart of ‘smart’ networking (Vervest et al., 2004), because of the coordination is directly linked with the key features of smart networking namely awareness, adaptability and learning capabilities (ibid.) of the community of networked businesses.

But who are the coordinators across boundaries in inter-organizational activities? The organizational literature has identified a number of roles related to boundary spanning activities (Thompson, 1967): gatekeepers (coined by Allen & Cohen, 1969) are the persons seeking and mediating new information outside the organizational boundaries and assimilating it into their organization. Their communication and absorption capabilities set natural limits to the extent of stimulus from outside the company. In addition to the above mentioned roles, the roles of champion, project leader, project sponsor and innovator have been found of importance in introducing assimilating innovations to organizations.

When the number of interfaces increases as a consequence of networked operations and outsourcing, the network also adds new dynamic interfaces towards outer world.

Does this mean that the number of boundary persons should increase in proportion to the number of firms, relationships, or complexity of the net-
work? Can smarter, more modern ICT compensate the need for more persons in boundary roles, or does it actually require more? So far, our understanding on the importance of innovators in a networked business is limited.

We address these research questions with three case studies. We start by introducing briefly the different roles of boundary spanners as we use them in our study. We describe each case in turn to gain holistic understanding of different coordination issues and analyze the absence and presence of roles in each context. Finally, we compare the cases in the absence/presence of the innovator roles, draw conclusions and recommendations for further research in the governance of the networks and their smart ICT.

Boundary Spanning Roles

The boundary spanning (Adams, 1976) roles necessary for successful introduction of an innovation has been a steady topic in the organizational and IS-literature. Early writings of gatekeepers (Allen & Cohen, 1969) illustrate the roles of seeking and mediating new information outside the organizational boundaries and assimilating it into organization. They boost the innovative capacity of an organization by expanding its resource base, by assimilating information from research, literature, fellows, colleagues, etc. On the other hand, innovator is depicted as a person who seeks to satisfy market needs by thinking of new ideas, developing solutions to problems, and identifying opportunities. Where gatekeepers tend to explore information objectively and critically, innovators are often creative individuals.

Champion was made widely known by Moss-Kanter. Originally a rather vague term induced variety of definitions in literature but has been more elaborate lately (Roure 1999, c.f. Esteves & Pastor, 2002). Roure defined a project champion as “any individual who made a decisive contribution to the innovation by actively and enthusiastically promoting its progress through critical stages in order to obtain resources and/or active support from top management”. Based on literature both on organizational innovation and project champions, Beath (1991) found that champions operate on basically three types of interrelated resources: information, material resources for acquiring information, and political support for material resources and rewards. Many times these resources are divided in person, so that there is a need for further elaboration, namely between sponsors, pro-
ject leaders or implementers. These roles are often identified in the context of technological or ICT-innovations (Howell & Higgins, 1990), but treated in bulk (e.g. Parr, 1999). Although most authors (see Roure, 1999) have found it difficult to distinguish between different types of roles in their empirical studies, we considered the following categories as useful in our research setting (inspired by Esteves & Pastor, 2002):

- Innovators, typically niche experts, who launch the basic idea.
- Champions (Moss-Kanter.; Parr, 1999) sell the idea, acquire resources and pave the road for the innovation by removing obstacles, inventing new solutions etc. Champion role often includes two meaningful categories (Esteves & Pastor, 2002)
  - Project leader, who organizes the project to take an innovation into use.
  - Sponsors, who help to overcome the obstacles during project and to gain top management support.
- Gatekeepers/boundary spanners, who actively seek new information and influences from outside the organization.
- Implementers, who coordinate the actual operational roll out of the innovation.

In the following case studies we aim at recognizing where and who are the idea generators, champions and gatekeepers in the context of business networks. We also have a look into information systems to assess whether they are used to compensate the need for more persons in innovating roles.

Empirical study

Our three case studies present different challenges and solutions to boundary spanning. The first one is a case of three companies aiming at developing a network providing ICT-supported services for overseas markets with modest results. In the second case study we dig deeper into local services markets by studying the attempts to employ modern ICT-tools as primary communication and coordination media between the customer and the supplier within the service activities. The third case describes a successful implementation by a focal company of ICT tools for coordinating and controlling global service vendor network with information systems.

The research data for cases I and II cover two years span. The research method applied in both cases was action research, i.e. we were involved in
the practical activities of the network and our actions had an effect on the
decisions made by the companies. The research projects organized multi-
ple workshops, meetings and interviews. The third case was based on a
case study in spring 2006, which included several interviews and group
discussions. All interviews were audiotaped, transcripted and checked by
the interviewees. Workshops and meeting were documented by memos.

The following discussion on coordination builds on the documented re-
search project data. The analysis of the boundary spanning roles is, in turn,
based on researchers’ reflection on the cases. The main researcher of each
case explored the development path of the innovation and constructed a
description of the roles affecting the process. To improve the reliability of
the findings they were cross checked by colleagues of the same project and
of other cases.

Case I – Partnering for service offering

The first case focuses on a process of joint service development for
global markets. The business network (consortium), consists of three cor-
porations (hereafter referred to as A, B and C). The primary focus is on the
cliente of the two consortium members (A and B).

![Figure 2. Topology of partners forming a consortium for service offer-
ing.](image-url)
Company A has become the leading supplier of capital goods within its own global segment and is generally considered the technology leader in its field. The shift from production towards customer orientation started with delivery project management. As the degree of integration of the separate components grew at the customers end, it became feasible and necessary to coordinate the delivery and design stages of the individual components more closely with partners before and during the delivery. This means that the whole machinery including automation and supporting ICT systems were supplied to customers in close co-operation with sub-contractors. Company A took the role of a coordinator in the delivery project. At present, the extreme cases are turnkey projects, when the company takes a main contractor role for the whole project with all components including automation and ICT systems configuration. The industrial and technical evolution (especially the growth of complexity) has thus changed the core competence of the industry from manufacturing to project delivery management.

**Coordinating boundary spanning activities**

The next step in the evolution of core competence of Company A has been stated in its business strategy: it is expected to move towards customer oriented service (desire to move closer to A, to the tier next to the customer in figure 2.). The company considers that the best way to deliver services worldwide would be to use reliable, static partnership network (consortium). The final outcome of this development might mean that operation and maintenance of the customers’ equipment may be outsourced to an alliance of company A with its partners. The possibilities emerge along with the advances in ICT, remote diagnostics, control and coordination systems; on the other hand there is constant pressure to cut costs.

The consortium was coordinated at the beginning as a research project funded by companies (20%) and National Technology Development Agency (80%). The focal company did not rule the development, but all the companies were given an equal power. All the companies assigned 2 to 3 persons to take actively part in the consortium meetings. Their task was also to locate the appropriate persons from their own organization when extra expertise was needed.

The length of a customer service project is several years. As there is need to visit the customer sites regularly, the consortium should have ex-
perts residing in nearby the customer sites. So far, the focal company had not outsourced those tasks, which were in direct contact with the customer. In order to come over the problem of having too less experts to fly to customers all over the world, it had tested of remote diagnostics connections with a few customers. Unfortunately, this method would not work for larger number of customers. Now it had to seriously consider the option of using as suppliers local MRO firms, which had tight contacts with their customer sites (marked with L in figure 2.). In order to enter into real partnership, it should also be ready to reveal its partners some valuable information concerning customers.

**Information technology**

The information technology solution proposed for the running of consortium service was based on hub, which would receive and distribute information between machines or people. The data would be collected from customers’ machines and analyzed by centralized experts in the headquarters. Additional data collection or roll out of proposed solutions would be carried out by expert centers residing in the country of the customer.

It was actually the coordination tools that proved to be more problematic. The parties acknowledged that especially due to long duration of the service contracts, it was important having tools for contract management and to have explicit process descriptions and change procedures. As the relationship with shared customer is multifaceted and long-term, situations will likely emerge when more than one of the parties comes into direct contact with the customer. Ideally, the parties should gather common information about the configuration and customer situation and record any modifications made, along with any anticipated changes in the performance of the facility. Again, as the parties are numerous and the relationships long-term, metadata should exist on the creator, responsible organizations, version history, variants and general rights-of-use of any digital documentation. (Heikkilä et al., 2004)

**Roles in boundary spanning**

The consortium had multiple innovators: Each firm had its own innovator and ideas how the joint service should be arranged. Unfortunately, these simultaneous ideas were generating a somewhat competing situation between the parties.
The members of the consortium disagreed how the costs and profits should be distributed between the members. For instance company C was willing to share both costs and profits equally. To the contrary, company A, providing the pivotal expertise in the consortium, claimed that as they supplied the most value added part of the service they should also receive more than equal share of profits. Because of disagreement none of the companies was committed enough to sponsor the consortium.

The companies outsourced the main project leader role to local university, whose researchers acted as facilitators or mediators between the parties. Their role was to aid the learning process of the consortium and to make sure that discussions systematically covered all the areas of business model. Organizational learning process within the consortium representatives did actually proceed nicely, since all the companies had an own representative who was acting as a gatekeeper, eagerly seeking new information and influences from outside the organization. Many of these persons were acting simultaneously also as project leaders towards their own organizations. However, none of the companies provided the consortium with a person who would actually implement the plan.

Case II – Joint process improvement

The second case is a study on a network of two organizations doing service business together. Industrial service business is considered as a set of activities taking place through interaction between the customer and the service provider, their physical resources and/or their information systems, and that are offered as solutions to the customer’s problem (Grönroos, 2001). A service is distinguished (from a product) by participation; the customer contributes the process, and have influence on the outcomes, quality and value of the service (Edvardsson and Olsson 1996). This means that the organizations are dependent on each other, their information and their joint processes. However, still the organizations are independent doing their business with their own customers and partners, from their own strategic points of views.

In contrast to the organizations’ previous experiences from networked business operations, in this case it is not subcontractor-customer relationship but relationship between two equal companies. One of the organizations has traditionally operated in a manufacturing industry. However, due to the changes in the business environment, they have lately moved to-
wards service business offering maintenance and problem solving services to their old customers. The other organization of the network has traditionally purchased machines from the manufacturer. Due to increased complexity of the machine and the changes in their business environment, they are not able to provide training and keep competent and skilled employees in-house. Basically, currently the staff can operate the machine and perform some simple maintenance work. Thus, the organization has started to search other partners that could help them in complex situations. There is a mutual need to do joint business within the network, as illustrated in Figure 3. The problem remains how to do it together.

![Figure 3. Topology of a network where customer and service provider aim at tighter cooperation.](image)

Basically, the business process is very simple. Either contract-based monitoring of the machine is performed and regular status reports including suggestions for improvement are produced, or problems are tackled one-by-one by gathering appropriate data, from the machine, for an analysis. In both cases, the process may include visits to a factory, although the analysis can also be performed from the distance by using data from different automation and process control systems.

**Coordinating boundary spanning activities**

Following the definition of service business, the role of participation is significant. However, effective participation requires also coordination,
which becomes problematic in multi-organization cultural context. For example, the service provider needs to coordinate their service process. Usually this is not a problem as the employees have got used to such activities. However, in complex problem solving situations, that is easily prolonged lasting up to a year, intra-organizational coordination and knowledge transfer become problematic.

Yet still more challenging is the coordination of inter-organizational work. Unfortunately often, when an improvement suggestion report is delivered to the customer, it disappears. This makes it impossible to the service provider to follow whether the suggestions have been considered thus, in the next case, they do not know whether an improvement was a result of their suggestion or some unknown factors. Although the customer acknowledges the importance of the report, they do not coordinate its deployment internally. This is most likely due to the persons receiving the report either do not see its value, or do not care about it. The receivers acting as gatekeepers are not familiar with the work mode, and are not personally awarded if the production of the machine improves. Nevertheless, the lack of awareness of considered suggestions have its implications to the business model in a large.

An automated coordination system or fixed cooperation models would solve many of the inter-organizational problems. However, our analysis revealed many gaps and details in the joint business operations. These include, for instance, weakly defined processes and information flows, fragmented ICT infrastructure, and a lack of contextual knowledge. To overcome these practical issues, the organizations need to change and coordinate not only their internal work processes but most importantly, to synchronize them. Also, especially the service provider believes that an ICT-based portal integrating the currently fragmented information from both sides and transferring it between the organizations would ease the situation. The customer remains more sceptical.

**Roles in boundary spanning**

The relationship between the organizations is not vendor-client, subcontractor-customer relationship. Instead, both organizations attempt to create an equal win-win situation where their operational activities are more or less intertwined. However, they do not share the same vision of how to do it, although they admit they still have to do it. The service provider prefers to have stronger connection (contract based) correspondingly causing the
customer to be bound with their services while the customer obviously pre-
fers weaker connection. This disorientation in the objectives is reflected
into the workers roles in both organizations.

In both organizations, there are people that seek new ideas to survival in
a changing business environment. The service provider attempts to move
away from manufacturing to developing new innovative services. The cus-
tomer, on the other hand, is more eager on innovating new ways to cut
down the costs. Outsourcing, automating, and improving the processes are
all equally relevant approaches. These ideas are not necessarily the same.
From the network point of view, the organizations are visioning two inno-
vative smart networks that are not necessarily parallel.

The role of champions is ambiguous. They try to promote the idea of
service business in their own organizations, from their own strategic view-
points, thus the objectives and ideas are not necessarily in line with the
other company. On the other hand, they try to influence other members of
the organization network. This biased approach creates many problems.
For instance, in the customer side, there are several champions (sponsors);
some arguing for the service business and tighter connections with the ser-
vice provider (especially middle management) while the others are more
aligned with consuming services only occasionally (top management,
floor-personnel). One may argue the former being predisposed by the ser-
vice provider. However, we tend to believe that they perceived the value of
service business and how such activities may cut their costs. This was
more evident on a floor-level than elsewhere thus they encouraged the oth-
ers.

Similarly to sponsors, the role of project leaders is slightly ambiguous.
In both organizations, project leaders are managing their internal processes
and projects as usual. Yet, when the activities require cross-organizational
interaction, the management and workflows break apart (c.f. Pekkola and
Munkvold, 2006). People fixing the problem, requesting information, or
fine-tuning the machine constantly consult the other side despite the defi-
nitions and limitations of the service agreement. Neither side make entries
to a database. Because of an instable status of the service business, espe-
cially at the customer side, the role of project leaders disappears.

Few champions and gatekeepers are the same person. They seek new al-
ternatives by monitoring the world beyond the organizational boundaries,
and promote or invalidate them in their organizations. This monitoring
may take place through journals and conferences, but may as well take
place through the service provider. In contrast to previous roles, gatekeepers’ role is mainly to act inside both organizations and not directly influence the other party or the network.

**Case III – Aggregated services delivery**

Third case is about a dynamic supply network that is build around its focal company, a global provider of infrastructure installations and services to specific industries. As physical presence is required in the geographical area of the customer, the company relies heavily on its projects on local suppliers.

![Figure 4. Topology of aggregated service delivery network.](image)

**Coordinating boundary spanning activities**

Few years back the focal company used to rent workers from its suppliers for certain periods of time to the projects. Now, instead of hiring work months the sourcing strategy is to buy work packages (fig. 4). The focal company outsources well over 90% of project tasks. It sees high level project management and supply network management as its core capabilities. The focal company wants to keep itself all positions with interfaces towards customers. It communicates with the customer and ensures that the information needed to accomplish the task is passed to each supplier. Because a typical project’s lead time is 4 months, the main coordination effort is to assign, schedule and control performance of supplier net. Furthermore, an important coordination task is change management, i.e. in
case of exceptions to replan and inform relevant participants about changed project delivery details.

Instead of static partner network the company considers that the most cost effective way to deliver customer orders worldwide is to use suppliers residing nearby customer sites. Thus it has to build a new supply network for each project. Depending on the scope and location of the project the number of suppliers may vary from 10 to several hundreds of suppliers. However, the focal company is very strict in the selection process as it does not want to endanger its brand name by using incompetent suppliers. Thus special attention in supply net coordination is paid to sourcing process, contract issues and continuous assessment of suppliers.

Information technology

During the past four years the focal company has heavily invested in information systems that would help coordination of the above described boundary spanning process. The coordination of projects is largely build on rigid work breakdown structure into work packages already applied in company’s ERP system. Sourcing phase is assisted with e-sourcing and e-auction tools. The delivery phase is assisted with an e-project management system, where work packages are further divided into specific work items. The focal company’s project manager assigns a due date for items. When the supplier has accomplished the item it adds the finishing date for that item to the system. After project manager’s and customer’s approval the system informs focal company’s ERP system that supplier’s bill can be accepted. In case of exception during work tasks, for example if there was some extra work needed to accomplish the task, the suppliers must fill in a formal change note to the system. Only thereafter it is processed by the focal company.

The suppliers are obliged by the contract to use the above mentioned information systems. If they do not fill in the data and upload required documents the focal company refuses to pay their bills. However, the situation is quite different in the relationship with customers. Since the focal company may be only one of tens or hundreds of vendors, it has not sufficient power to force its customers to use these systems. They can, though, provide incentives, such as a discount on prices, if the customer uses these information systems to acceptance of work packages and of documentation.
Roles in boundary spanning

The innovator role in this case network belongs to focal company’s responsibilities. The network was led by the focal company and it has power over actions of its suppliers. Also the network is dynamic to such extent that no other firm in addition to the focal company is present continuously. This means that no innovations regarding the network coordination is expected from other parties of the network.

The driver for innovations is cost effectiveness. The focal company aims with automation and process changes to improvements in two matters: collaboration or transaction. Collaboration includes information transfer within the network, among others documents, instructions and information on the state of project. The latter, transaction, refers to cost effective handling of supply orders, order confirmations, acceptance, billing and money transfers.

In “Aggregated services delivery” -case we can identify clearly two types of champions: The head of the department acts as a sponsor who encourages and assists team members, and secures the support of top-level management. There were also couple of project leaders whose responsibility was to coordinate activities such as planning and organizing projects, and balancing project goals with available resources. In supplier companies the role of project leaders is make sure that focal company’s rules and standards are followed correctly. The focal company facilitates guides and controls the implementation. It provides training and material for the suppliers to roll out the required information systems. Thus it makes sure their systems are being used as designed planned.

Empirical summary

Table 1. summarizes the boundary spanning roles in each case. There seem to be some association between the accuracy and coverage of role definitions and the success of the network. In the first case there no sponsors or implementers and the network collapsed after a while. Instead there were numerous innovators, project leaders and gatekeepers. However, these roles were in some companies being played by one single person. Altogether, there were too many people, each having different opinions, thus a joint network vision failed. There was no clear purpose for a network to exist.
The other two cases have better defined roles. In the case II, the companies had mutual understanding about the need for a network. Yet they did not have a shared agreement of the degree of cooperation. This unclear vision affected the network making practical operations ambiguous. At this moment, it is too early to know how this uncertainty is reflected to the success of the network of Case II.

In Case III the focal company had clearly defined all roles. The roll out of innovation was successful, at least from the focal company’s point of view. There was no need of other parties of the network to other boundary spanning persons except the implementers.

<table>
<thead>
<tr>
<th>Role</th>
<th>Partnering for service offering</th>
<th>Joint process improvement</th>
<th>Aggregated services delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective</strong></td>
<td>Cost effective global service delivery. Generic service concepts.</td>
<td>Just in time service and maintenance for optimal machinery utilization or problem solving.</td>
<td>Cut costs, reduce transaction costs by business driven delivery. Exceptions. Easy to join. Business driven</td>
</tr>
<tr>
<td><strong>Innovator</strong></td>
<td>Innovators in all the companies. Contradicting opinions</td>
<td>Innovators in both companies. Agreeing the need for cooperation, but contradicting opinions of how to do it.</td>
<td>Innovators only in focal company</td>
</tr>
<tr>
<td><strong>Champion (project leader)</strong></td>
<td>In all the companies + outsourced facilitators</td>
<td>Each company, own project standards. Cooperative practices are not well defined, many exceptions.</td>
<td>Focal company’s guidelines set standards.</td>
</tr>
<tr>
<td><strong>Champion (sponsor)</strong></td>
<td>Missing. Sponsor clearly needed.</td>
<td>In each company, with different perspectives. A need of a person having a general idea and power at the network is evident.</td>
<td>Sponsors only in focal company.</td>
</tr>
<tr>
<td><strong>Gatekeeper</strong></td>
<td>Several in all parties</td>
<td>In both companies</td>
<td>In all parties</td>
</tr>
<tr>
<td><strong>Implementer</strong></td>
<td>Missing</td>
<td>Both sides, not necessarily doing the same activities</td>
<td>Focal company facilitates guides and controls.</td>
</tr>
</tbody>
</table>

Subsidised development. Marriage like relationship. Non identical visions reflected into the network. The roles internally in line with
The network collapsed. Each organization's objectives, but contradictory externally, i.e. on a network level.

Table 1. Summary of boundary spanning roles in three empirical cases.

Conclusions

In this article we analyzed boundary spanning roles in the context of business networks. On the basis of three differing cases we draw following conclusions:

First, it seems that all the roles would be necessary in coordinating the assimilation of networked business models (Applegate, 1991). For example, in ‘Partnering for service offering’-case the development of the business model halted. It was evident that the role set was inadequate and the representatives were having too arbitrary but broad role set. With the former we mean that the role of sponsor was not there when needed to defend and advocate the joint business model. The latter means that a few of the company representatives were bearing all the roles in same person: an individual tried to innovate, gatekeep, and lead the project at the same time. This turned out not the feasible solution, because it is not a credible role within a knowledge-based organization he represented.

Second, it seems that the growth of complexity in coordinating the introduction of a novel ICT-enabled business model grows quickly with the number of equal partners. There must be equal roles personified in each of the companies, unless no mediating device is introduced. This is evidenced by the battle-of-sexes type of setting in the case ‘Joint process improvement’, where equal partners were intertwined in mutual process of continuing relationship for the time being, yet they may disagree about the actual implementation of the business model. In ‘Partnering for service offering’ the consortium was unable to settle fundamental issues, e.g., the incompatible incentive schemes, and sharing of customer data. In our third case ‘Aggregated services delivery’, the coordination complexity was reduced by the focal company, because it decided and determined the actual implementation of the business model. It stuck tightly to customer interface, and held the suppliers, contract manufacturers and subcontractors at arm’s length. This way it was possible to have an asymmetric set of roles in the coordination of the business network – at suppliers’ side it required fore-
most project leaders to make the things happen. Furthermore, the implementation success and real benefits were further confirmed in the form of a joint IT-application, which required a substantial investment by the focal company (that any other party could have never been able to afford, alone or together).

Third, if being introduced the IT-application should serve as an incentive structure: In the case of ‘Aggregated services delivery’ -case it was only after uploading required documents and reporting of performed actions the suppliers got their financial payments.

In conclusion, it seems that all the roles are necessary in the assimilation process of an innovation in the context of networks. Within our cases, there was a vast difference in the number of boundary spanners needed. This seems to depend primarily on two broad features of the focal company: Its negotiation power and its resources in deploying, helping and securing a functioning implementation of a formal model globally (here a shared information system). This way the in-built market mechanism replaces the personal innovator engagement (Ring & van de Ven, 1994) and enforces the relational arm’s length contracting to everyday practice. In a global setting is probably the right way to go, but in a long term relationship - such as in case of ‘Joint process improvement’ - the viability remains to be foreseen.

References


Coordinating and boundary spanning roles of business networks


25. Fighting SARS with a Hastily Formed Network

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Abstract

Globalization and advanced Information and Communication Technologies have enhanced the role of networking between organizations in business and public sectors. Examples of public networking are disaster relief (Stephenson, 2004), disease control management, military (coalition-based) campaigns (Alberts and Stein, 2000), and law enforcement. We discuss the SARS (Severe Acute Respiratory Syndrome) case to learn how global interorganizational networks can be successfully instantiated.

The purpose of this study is to improve our understanding of interorganizational network instantiation and to examine some mechanisms leading to successful interorganizational network performance. The paper is structured as follows. First, we present briefly the SARS case. Next, we discuss the concept of hastily formed networks and some concepts that have been introduced by Hagel and Brown (2005). Finally, we analyze the SARS case with these concepts and draw some lessons from the case study.

1. Introduction

Globalization and advanced Information and Communication Technologies have enhanced the role of networking between organizations in business and public sectors. Business examples include networks in clothing, aviation, car and electronics industry (for instance the battle of standards for new generation electronics). Examples of public networking are disaster relief (Stephenson, 2004), disease control management, military (coalition-based) campaigns (Alberts e.a., 2000), and law enforcement. Interorganizational networking rallies competencies (Katzy and Crownston, 2001) and leads to coordinated performances. Potentially, networks outperform organizations and dyads of organizations (Smith e.a., 1995) in terms of speed, flexibility, reliability, knowledge intensity, scale, and effi-
ciency. Interorganizational networks have the potential to respond to urgent events or opportunities to create value.

At the same time, failures of interorganizational networking have become apparent. Those in the public sector tend to draw most attention in the media. The multi-agent US government response to the Katrina disaster was considered unsuccessful, as were many international relief efforts to a certain extent (Daly Hayes and Weatley, 1996). Other unexpected major disasters such as the Tsunami in the Indian Ocean in December 2004 and the devastating earthquake in Kashmir in October 2005 revealed the global need for a deeper understanding of network coordination in response to unexpected major disasters.

The purpose of this study is therefore to improve our understanding of interorganizational network instantiation and to examine some mechanisms leading to successful interorganizational network performance. By instantiation we mean an organized, concerted effort to configure resources into a means-end relationship within a short time span. In the process of instantiation interorganizational networks undergo a ‘phase transition’ from a defined state into another state in response to changing levels of urgency awareness (Johnson, 2001). Network performance refers to the collective achievements that could not be achieved by the network actors individually.

Network response to major disasters requires an enormous amount of coordinated activities at different levels and in different phases of the response. In this paper we confine ourselves to the instantiation of knowledge and information which, to a large extent, determines the quality of network response (Denning, 2006). We discuss the SARS (Severe Acute Respiratory Syndrome) case to learn how global interorganizational networks can be successfully instantiated. For analyzing the SARS network we use the recently coined concept Hastily Formed Networks (HFN) (Denning, 2006) and network dynamic as discussed by Hagel and Brown (2005). The SARS case is widely discussed in the academic and professional literature. However, few attempts have been made to understand the SARS response from an interorganizational network perspective. For the case material of SARS we rely mainly on abundantly available secondary data such reports and documents, academic papers and books, websites (especially of the World Health Organization).

The paper is structured as follows. First, we present briefly the SARS case. Next, we discuss the concepts of hastily formed networks and some concepts that have been introduced by Hagel and Brown’s (2005). Finally, the SARS case is analyzed using these concepts and we draw some lessons from this case study.
2. The SARS Outbreak

The SARS outbreak commenced in Guangdong (China) on November 2002 and spread to other countries – such as Singapore, Hong Kong, Canada – following travel patterns of infected individuals. The SARS outbreak shocked health care systems worldwide. SARS was a new corona virus not previous identified in humans and animals. There was no knowledge about how to identify, diagnose and treat SARS. Once SARS reached Hong Kong it spreaded, within a few days internationally “with the speed of an airplane” (National Advisory Committee on SARS and Public Health, 2003). China (including Hong Kong) was severely attacked: more than 600 people died (Table 1). As of early June 2003, the World Health Organization (WHO) counted 8098 people that were infected, 774 died. Most countries in the western world were hardly hit by SARS. The exception was Canada (Toronto and Vancouver) where 251 people were infected and 43 of them died. In July 2003, WHO declared that SARS had been contained and was no longer viewed as a global threat. Considering the potentiality of the threat of SARS as a ‘globalizing disease’ the impact remained modest.

<table>
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<th>Female</th>
<th>Male</th>
<th>Total</th>
<th>Number of deaths</th>
<th>Case fatality ratio</th>
<th>Date onset first probable case</th>
<th>Date onset last probable cases</th>
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<td>4</td>
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<td>14</td>
<td>25-Feb-03</td>
<td>5-May-03</td>
</tr>
<tr>
<td>Republic of Ireland</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>27-Feb-03</td>
<td>27-Feb-03</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>19-Mar-03</td>
<td>19-Mar-03</td>
</tr>
<tr>
<td>Russian federation</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>5-May-03</td>
<td>5-May-03</td>
</tr>
<tr>
<td>Singapore</td>
<td>161</td>
<td>77</td>
<td>238</td>
<td>33</td>
<td>14</td>
<td>25-Feb-03</td>
<td>5-May-03</td>
</tr>
<tr>
<td>South Africa</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>100</td>
<td>3-Apr-03</td>
<td>3-Apr-03</td>
</tr>
<tr>
<td>Spain</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>26-Mar-03</td>
<td>26-Mar-03</td>
</tr>
<tr>
<td>Sweden</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>28-Mar-03</td>
<td>23-Apr-03</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>9-Mar-03</td>
<td>9-Mar-03</td>
</tr>
<tr>
<td>Thailand</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>2</td>
<td>22</td>
<td>11-Mar-03</td>
<td>27-May-03</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1-Mar-03</td>
<td>1-Apr-03</td>
</tr>
</tbody>
</table>
Table 1 clearly shows that China (including Hong Kong and Taiwan) and Singapore were severely hit by SARS. In the western countries the spread of SARS remained limited to a few cases. A striking exception here is Canada where quite a number of SARS cases were identified. New was the fact that many (1707) health care workers were infected; 21 of them died.

3. GOARN: Spider in the Information Web

In March 2003, the WHO issued a global alert for the outbreak of SARS. With the advance of global traveling, disease outbreak has become a major concern for public health officials. The SARS alert was enabled by WHO’s Global Outbreak Alert and Response (GOARN) system. Commenced in 2000, this system tracks outbreaks and spreading of SARS continually. GOARN consists of experts in various areas whose knowledge must be integrated to combat major diseases. Teams on the ground in relevant countries receive information from and provide information to WHO. These teams work together through video- and teleconferencing. In cooperation with other agencies, WHO orchestrates a global network for monitoring disease outbreaks and communicating about these, mainly through its website.\(^{20}\)

In March 2003, WHO commenced planning for addressing the risks of SARS in multiple areas. Their efforts included arranging for medical supplies, mobile teams of specialists traveling to sites with urgent situations, and organizing networks of experts trying to develop a better understanding of SARS diagnosis and treatment. WHO organized multiple networks: organizations involved in medical supply logistics; epidemiologists studying patterns of outbreaks; clinicians involved in specific SARS case were

\(^{20}\) http://www.who.int/csr/sars/goarn2003_4_16
interconnected to share experiences; and laboratory staff across the world attempting to understand causes of the disease.

GOARN operates according to guiding principles to improve coordination. These principles include21:

1. WHO ensures outbreaks of potential international importance are rapidly verified and information is quickly shared within the Network.
2. There is a rapid response coordinated by the Operational Support Team to requests for assistance from affected state(s).
3. The most appropriate experts reach the field in the least possible time to carry out coordinated and effective outbreak control activities.
4. The international team integrates and coordinates activities to support national efforts and existing public health infrastructure.
5. There is a fair and equitable process for the participation of Network partners in international responses.
6. There is strong technical leadership and coordination in the field.
7. Partners make every effort to ensure the effective coordination of their participation and support of outbreak response.
8. There is recognition of the unique role of national and international nongovernmental organizations (NGOs) in the area of health, including in the control of outbreaks. NGOs providing support that would not otherwise be available, particularly in reaching poor populations. While striving for effective collaboration and coordination, the Network will respect the independence and objectivity of all partners.
9. Responses will be used as a mechanism to build global capacity by the involvement of participants from field-based training programs in applied epidemiology and public health practice, e.g. Field Epidemiology Training Programs (FETPs).
10. There is commitment to national and regional capacity building as a follow up to international outbreak responses to improve preparedness and reduce future vulnerability to epidemic prone diseases.
11. All network responses will proceed with full respect for ethical standards, human rights, national and local laws, cultural sensitivities and traditions.

SARS showed the successful orchestration of globally distributed medical research laboratories in identifying the SARS virus by the WHO. This international scientific cooperation was unusual. International health treaties were dominated by state sovereignty; international intervention in an-

other state’s internal activity used to be unthinkable (Wallis, 2005). In 2000 the WHO launched a new vision on its role in coordinating global outbreak of infectious diseases. The WHO relied on its international mandate based on the International Health regulations, and unique country specific experiences and knowledge.

4. Code Orange

Apart from these successes, SARS revealed the failure of national health care systems (Canada) in fighting global infectious diseases. Underpinning this problem was the underinvestment in microbiological research and testing capacity at the laboratories in Canada. While researchers in Hong Kong were able to correlate clinical and laboratory features of SARS with epidemiological data, the Canadian researchers were not able to do so. The latter were too busy with patient care and did not find time to do the required research. From a more operational perspective, the state of emergency (Code Orange) was declared in Canada in March 2003. This threatened the Canadian health care system. Code Orange is part of the Uniform Emergency Codes which has been adopted by the Ontario Hospital Association in 1993. It indicates an external disaster which alerts hospitals to prepare for a rapid influx of patients being brought to hospital by ambulances. The code is intended to be applied to a specific area and to be used for a limited period of time. However, it soon appeared that the Code Orange was not the appropriate response for an infectious disease outbreak such as SARS. The code paralyzed the health care system because there was in fact no extraordinary number of incoming patients, as would be the case during natural disasters. In fact, the challenge in controlling SARS was to significantly restrict access to healthcare facilities. Moreover, Code Orange was not meant for such a broad geographic area and for a sustained period of time. As a consequence, many hospitals unaffected by SARS were forced to reduce their service level significantly. They delayed current procedures and thereby put critical patients at risk. The SARS case illustrates that an organization (the Canadian health care system) might be well-prepared for responding quickly to risks that are induced by the external environment (calculated risks). But the same organization finds it difficult to respond adequately to the indirect and unintended consequences that threatened the system self. Furthermore, procedures and codes (such as Code Orange) may seem reasonable in the eyes of disaster planners. But their effectiveness remains unknown in case of a real disaster that may differ from the anticipated situation.
The purpose of this study is to improve understanding of interorganizational network coordination and to examine the drivers of successful interorganizational network coordination. Before analyzing the SARS case with its mixture of successful and less successful operations, we introduce concepts for building a theory of interorganizational network instantiation.

5. Hastily Formed Networks

We define networks as exchange structures with their own governance structure and patterns of interaction in which flows of resources between independent units (or individuals) take place (Van Baalen, e.a., 2005). Network governance refers to interorganizational coordination that differs from market- and hierarchical coordination because they employ a wider set of coordination mechanisms (Grandori, 1999). Most research focuses on existing networks with stable relationships, while we are interested in instantiating and emerging network relationships and coordination. In the case of emerging networks, social structure is conceived as an outcome and not as a starting point of repeated exchange relationships between participants of the network. For the SARS response network no existing social structure was available. Network structures had to be formed and instantiated in response to the threat of the highly infectious SARS virus.

Denning (2006) recently coined the concept of Hastily Formed Network (HFN) which refers to multiple network organizations that are instantiated in response to disasters like earthquakes, terrorist attacks, hurricanes, global infectious diseases. HFN’s can be classified according to the kind of events to which they have to respond and for which and organization/country can be prepared. The categorization concerns the relationship between network capabilities and the type of event. Eventually, the type of response gravitates to the availability of information about the event that disrupts our social and economic worlds.

<table>
<thead>
<tr>
<th>Category of Events</th>
<th>Characteristics</th>
<th>Examples of Events</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K-Events:</strong> Situation and Network Factors Known</td>
<td>Network is in control:</td>
<td>Fast response team for time-critical business problem or opportunity (focused, contained task environment)</td>
</tr>
<tr>
<td></td>
<td>– Network knows what to do, and uses existing network structures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Network may choose not to respond</td>
<td></td>
</tr>
</tbody>
</table>
25. Fighting SARS with a Hastily Formed Network

<table>
<thead>
<tr>
<th>KU-Events: Mixture of Known and Unknown Factors</th>
<th>Normal response activation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>− Network knows what to do, yet doesn’t know time or place</td>
<td></td>
</tr>
<tr>
<td>− Responding network structure known</td>
<td></td>
</tr>
<tr>
<td>Source: adapted from Denning, 2006</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>U-Events: Situation and Network Factors Unknown</th>
<th>Network overwhelmed or disrupted:</th>
</tr>
</thead>
<tbody>
<tr>
<td>− Network doesn’t know what to do and doesn’t know time or place</td>
<td></td>
</tr>
<tr>
<td>− Responding network structure unknown</td>
<td></td>
</tr>
<tr>
<td>Source: adapted from Denning, 2006</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Kinds of events requiring responses from HFN’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source: adapted from Denning, 2006</td>
</tr>
</tbody>
</table>

Responding adequately to U-category events implies that a jump (ad hoc stretch) has to be made from an unprepared situation to tightly coordinated action in order to contain the rapid spreading of the SARS virus. Figure 1 shows that, in order to respond adequately, preparedness should be connected to the capability to act.

Figure 1 Preparedness and Activation
Relying on recent insights of Hagel and Brown (2005) about global process networks we argue that four elements are crucial for understanding SARS as an HFN’s: dynamic specialization, connectivity and coordination, leveraged capability building, and network orchestration. In the next section we discuss these network elements, applied to the SARS case.

6. Dynamic Specialization

Hagel and Brown use the concept of dynamic specialization to refer to the commitment to eliminate resources and activities that do no differentiate firms and to concentrate on accelerating growth from capabilities that truly distinguish the firm in the marketplace. In the world of health care systems can mean something different. The SARS case has demonstrated the indisputable role of scientific research and the role of medical labs. The need to specialize in different activities like diagnoses of infections, characterization of micro-organisms, reference services, and support to epidemiological surveillance and epidemic investigation. Acquiring deep knowledge into these different most important knowledge domains requires large investments in basic and fundamental research. However at the beginning of the outbreak of the corona virus there was no knowledge how to identify, diagnose and treat SARS. David Heymann, a veteran epidemiologist at the WHO, stated that “.. we had no cause of the disease, we thought it was infectious, no vaccine, no drugs” (quoted in: Abraham, 2005: 84).

The urgency awareness put research labs under pressure and resulted in an unprecedented speed of scientific discovery and publication of research results (National Advisory Committee on SARS and Public Health, 2003). New knowledge had to be created and exchanged between globally distributed research labs in order to find proper diagnoses and treatments methods. The results of this global collaboration of the research labs were quite amazing. SARS was first identified in February 2003. The first scientific papers describing SARS were published already in March 2003 on the New England Journal of Medicine. They came from the research labs in Hong Kong and Canada. The following weeks, papers were published in high-ranked medical and scientific journals with traditionally long lead times like The Lancet, British Medical Journal, Science, New England Journal of Medicine, and JAMA – The Journal of the American Medical Association. In the period March – July 8 256 SARS papers were written by 38 countries (Chiu e.a., 2004). Interestingly, only 17% of SARS-related papers resulted from international collaboration. This indicates that spe-
cialization within research labs or research groups and fierce competition between those researchers still dominated but that through instant flexibili-
ization of the publication system researchers were able to identify SARS cases and work on new treatments.

7. Connectivity and Coordination

Getting access and mobilizing resources of various specialized organiza-
tions appeared to be the most important success factor in the global at-
tempt to control and contain the spreading of SARS. Perhaps more amaz-
ing than the speed of scientific discovery of the corona virus was ‘the almost instantaneous communication and information exchange’ about various aspects of the network response (Gerberding, 2003). Hardly any modern communication tool was left unused to disseminate up to date in-
formation to health care workers, travelers, clinicians, health officials, re-
searchers etc. The first scientific papers were published online in order to
get immediate access to the scientific findings about the corona virus. By setting up the Global Outbreak Alert and Response Network (GOARN) in March 2003, the WHO had a potent role as key coordinator and interpreter of epidemiological information. The WHO decided to set up a secure web-
site where each research lab could post its findings. Daily teleconferences
were organized to discuss the research results and to share information. Be-
cause of the firm competition between research labs, the WHO guaran-
teed that research data would be kept confidential and the labs and re-
searchers were not allowed to use someone’s finding without prior permis-
sion (Abraham, 2004). This “novel approach to science”, as Abraham
(2004) calls it required a lot of diplomacy and patience from the part of the
WHO-coordinators. On one hand they had to ensure that knowledge and
information sharing was optimized by connecting all relevant research labs
to each other in order control and contain global epidemic as soon as pos-
able. On the other hand they had to cherish the competitive environment
in which international reputed researchers were used to work in. The WHO
coordinators hoped to publish a single scientific article in the name of all
participating laboratories. However it soon appeared that the research
groups started to publish their research results individually Abrahams,
2004).

The central role of modern information and communication technology
became apparent in the failure of the Canadian health care system to re-
spond adequately to the SARS outbreak. Professor Johnson, responsible to
set up a SARS surveillance system in Canada stated that Canada was un-
able to provide optimal support for outbreak investigation and manage-
Because a sound database and new software tools to deal with tracking cases and contacts were missing at the moment of the breakout. This prevented researchers and health care workers tracking infectious disease and outbreaks because of “an archaic DOS platform used in the late eighties that could not be adapted for SARS” (quoted in: National Advisory Committee on SARS and Public Health, 2003: 29).

The website of GOARN provided up to date information, not only for scientists, public health officers, and policy makers but also started to communicate directly to citizens. This open information strategy was quite new for the WHO which was traditionally slow acting global organization in which decisions mostly took years of ponderous debate and in which individuals governments tend to obstruct decisions to defend their own interests (Abraham, 2004). SARS instantly transformed the WHO into rapid responding, and to a large extend independent, spider in the web of information processing.

Probably more important than connectivity provided by modern information and communication technologies was the social or political connectivity. While in November 2002 the first patient was identified with a mysterious respiratory disease in the Chinese Guangdong province, it was only in February 2003 that the Chinese government informed (still not complete) the world through a press conference about the disease outbreak. The SARS outbreak was no more under control. In April 2003 the Chinese press was allowed to publish about the SARS and only then a WHO team was allowed to visit the province of Guangdong. Until February 2003 the Chinese government was able to prevent scientists, healthcare workers, doctors, patients and media to disclose information about the mysterious disease to the outside world. In early February an anonymous SMS began circulating in Guangzhou about this new disease that in the end was caught up by people from the WHO global influenza surveillance network. From then on the WHO started to put the Chinese government under pressure to open up and to exchange information about SARS.

8. Leverage Capability Building and Network Orchestration

Although the WHO orchestrated the network of scientific laboratories, no party dictated top down what different labs would do, what viruses or samples the researchers would work on, or how information would be exchanged (Surowiecki (2003). The labs agreed that they would exchange research data, and figure out by themselves the most efficient way to divide up the work. The very fact that the labs were working independently ap-
peared also a particular strength in their search for identifying the SARS virus.

However the success of the SARS-HFN cannot be fully explained by the international collaboration of research labs, facilitated by GOARN. The GOARN operated as what Hagel and Brown (2005) call a ‘loosely coupled interface’ between researchers, representatives of national health care systems, and the public. When the WHO, spurred on by the resolute leadership of director-general Gro Harlem Brundland, decided upon the open information strategy, rather independently from the continuously conflicting national governments, it invited scientists, public healthcare workers, policy makers, travelers, and citizens to collaboratively help to control and contain the spreading of SARS. This open information strategy helped to leverage untapped resources and allowed people to take responsibility. It sharply contrasts the closed information approach of the Chinese government during the first three months of the SARS outbreak.

The SARS case also illustrates the need for a high level of preparedness at country and organizational levels. Networks capabilities build on the availability of specialized knowledge and competencies to instantiate this knowledge way and to translate and use this knowledge in coordinated action. Canada, the country that was hardest hit by SARS outside Asia suffered from an outdated IT-infrastructure, unconnected information flows, unclear responsibilities, a failing alert system, a lack of coordination, a weak analytical capacity of the Ontario Public Health Branche, and a lack of involvement by the federal government (Zhan, 2004).

The quality of the response of HFN’s therefore largely depends on the quality of information and information flow at the network and organizational/country level and within the network. Here it is important to distinguish between the network and the organizational (in this case country) level. In the end the alertness and response of the HFN depends on the quality of the information and information flow at the organization/country level. The SARS case included successful instances of coordinating specialized knowledge and translating this knowledge into swift, relevant, local action. Explaining the difference in performance requires attention for (the interplay between) two levels of analysis: organizations (hospitals, World Health Organization), and the network level. The SARS case suggests that individual organizations’ research labs accumulate specialized knowledge. In addition, they participate in inter-organizational research networks in the area of disease control. We call the latter network transactive memory (NTM) (knowledge of who knows what at which organization), an extension of the traditional transactive memory concept (Moreland, 1999). NTM combined with specialized organization level knowledge drives a network’s potential for coordination. This latent net-
work capability must be activated at unexpected times. The actual SARS outbreak in 2003 made coordinated response urgent in order to contain the disease and avoid a global epidemic. The World Health Organization took on the role of network orchestrator. It coordinated specialized knowledge from globally distributed research labs, and it ensured translation of this knowledge into global and local response. Canada, the unsuccessful case, decided in the early 1990s to economize on research labs. This jeopardized long term development of local specialized knowledge and thereby participation in global knowledge networks. Resourcefulness of network nodes thus matters for network level performance.

9. Lessons from the SARS Case

As global cooperation between organizations will increase, it is important to understand the coordination dynamics of interorganizational networks. However interorganizational networks are mostly understood in terms of rather stable network relationships. We think it is important to search for management and organizational concepts, like hastily formed networks, dynamic specialization, connectivity and coordination, network orchestration and leverage capability building to understand new dynamics of interorganizational globally operating and agile networks. In this paper we discussed the SARS case which can be viewed as a clear example of a non-stable, hastily formed network. We were primarily interested in the ways the SARS network was instantiated. The SARS case is interesting because contains very successful and very unsuccessful examples of network instantiation. Several interesting lessons can be drawn the SARS case.

1. The quality of the network response largely depends on the quality of the information and the information sharing within the network;
2. Providing a proper ‘conversation space’ (Denning, 2006), information rich and interactive websites and information systems, appears to be of crucial importance for publishing and sharing information;
3. Deep, specialized knowledge proves to be the core resource of interorganizational networks;
4. However the values of specialized knowledge only accrues only when it is dynamically connected to other specialized knowledge;
5. Open information strategies allow people with different acting roles to participate and to take responsible action.
6. Network performance depends to large extend on the level of preparedness of individual network contributors;
7. Independent network orchestration proves to be one of the main success factors for a high level network performance;
8. The SARS case showed that a high level of competition between knowledge providers can co-evolve with a high level of collaboration.

10. Future Research

The recent rise of globally Hastily Formed Networks like SARS, challenge our current understandings of networks as one of the dominant organizational forms. Networks, like any other organizational form, develop over time and can be instantiated towards coordinated actions. However in the case of SARS diagnosing and treatment expertise were lacking, (trust-) relationships at a global network level were often not yet established and network leadership was hardly developed. Although there is a vast network research literature, less attention has been paid to the consequences of the ‘compression of time’ for the emergence of networks in response to existential threats. Research into Hastily Formed Networks not only requires multilevel and multi-theory analyses like Monge and Contractor (2003) argue, but also reconsideration of our theoretical knowledge about networks. Of crucial importance here is to understand the impelling force of the urgency awareness that drives the ‘phase transition’. Future research should address questions such as: Why did people start to collaborate without any antecedents? Why did the WHO receive legitimate leadership from national governments to orchestrate the SARS fighting campaign? How could the GOARN website play such a dominant role in the coordination of research activities and spreading of information about SARS to the wider public. And, how can global information systems play a role in the prevention and containment of unexpected major disasters?

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26. Customer-Centric Business Networks: Case of the Evolutionary Network of Octopus

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“While trials or early stage deployments of similar systems have been made in Japan, Singapore, Rome and elsewhere, no major market has replicated the breadth or depth of Hong Kong's Octopus experience.”
--- Reuters (4.6.2002)

1. Introduction

What is the primary focus of research on performance outcome of business networks? Gulati (1998) argued that it is to answer the question of what are the performance benefit organizations sought from them. There have been various studies that have documented the varying performance improvement ranging from organizational learning (Hamel, 1991; Powell, Koput, & SmithDoerr, 1996), innovation (Shan, Walker, & Kogut, 1994) and financial results (Hinterhuber, 2002). However, while researches have focused on inter-organizational relationships in business networks so far (Madhavan, Koka, & Prescott, 1998), the role of customer in business network has received less attention (Fleisch & Powell, 2001; Gulati & Kletter, 2005).

Nowadays, a customer is no long “someone” who only buys products and services, rather, (s)he is the “someone” whose problem organizations exist to solve. It has been noted that capturing the capabilities of many individual organizations to fulfill customer needs and compete effectively is essential for smart business networks (Vervest, van Heck, Preiss, & Pau, 2005). In such loosely structured network, customers become integral participants of the business network (Vervest et al., 2005) and are recognized as the core of relational capital of network organizations (Gulati et al., 2005). This study will concentrate on the customer dimension of the business network and demonstrate that the growth of business network is linked to the ‘customer relationship ladder’ which the focal firm (‘network
26. Customer-Centric Business Networks: Case of the Evolutionary Network of Octopus

Orchestrator’) is climbing. Using case of the evolutionary network of Octopus that developed during last decade, we answer the following research question: How do business networks sustain a “win-win” situation for both customers and network members? And what are implications to the smart card adoption in Dutch transport industry? The contribution of this study lies in its ability to 1) empirically validate the customer relationship ladder developed by Gulati and Kletter (2005); 2) extend the network theory on evaluating network performance by incorporating customer’s dimension; 3) present implications for the Dutch transport industry.

2. LITERATURE REVIEW

Business Network Performance

Prior research on business network has given valuable insights on the behavior of firms in their business networks (e.g., with alliances) and the performance consequences from such partnerships. The unit of analysis that is usually adopted is the firm or the alliance in an asocial context (e.g., transaction costs or resource dependence theory). Recently scholars have claimed that firm behavior and performance are embedded in the social structures of its network (Kogut, 2000; Zaheer & Bell, 2005). And the unit of analysis from firm and dyad level has further extended to the network level. Among numerous studies on business network performance, few have reported high failure rate of alliances, while several others have strived to identify the success factors, including management of the alliance, building trust with partners, regular information exchanges with partners (Gulati, 1998). Different from previous research, which has the primary focus at the alliance level, this study emphasizes on customers as the focal point.

Customers are Key to Business Networks

Among prior researches on business network performance, little attention has been paid to include the customer dimension. Only until recently Gulati and Kletter (2005) in their “shrinking core and expanding periphery” article have included customers in their “relationship-centered organizations”. They argue that an organization is built on relationships: relationship with customers, suppliers, alliances and internal sub-units. Effectively exploiting and leveraging relational capital (the value of a firm’s network of relationships) will create a differentiator and is key to the long-term success. A relationship-centered organization is a net-
worked, agile, and highly adaptive entity that transcends traditional boundaries as it develops deep and collaborative relationships. “ Shrinking the core”, businesses increasingly focus on their core activities while outsourcing the remaining ones to strategic partners. At the same time, they are expanding the “periphery” by tying up and down the value chain. Their empirical research is based on a survey conducted to Fortune 1000 companies. The result shows that more than two-thirds of the top quartile firms devote their primary strategy focusing on meeting customer expectations and building long-term customer relationships.

**Network Orchestrator Governed Business Network**

How to configure business network in such a way that customer and network member preferences are satisfied is the responsibility of network orchestrator (Koppius & van Heck, 2004). A network orchestrator has an overview of the resources and capabilities of the network members on one hand and the demands of the end-customers on the other hand. In their illuminating study, Koppius and van Heck (2004) demonstrated how the Dutch Flower Auction as network orchestrator employs supply-driven and demand-driven market mechanisms to balance adaptation (short-term requirement) and adaptability (long-term requirement). Their research extend the prior efforts that linked orchestration with a firm’s financial results (Hinterhuber, 2002). Hinterhuber introduced the concept of ‘virtual value chain orchestration’, which refers to way of creating and capturing value by structuring, coordinating, and integrating the activities of previously separate markets, and by relating these activities effectively to in-house operations with the aim of developing a network of activities that create fundamentally new markets. There are mainly two tasks of orchestrator when creating a new market. The first is network configuration for selecting the partner companies and the second is network management for optimal resource utilization. Evidence seems to suggest that six steps can be distinguished in the process of the orchestration: 1) analysis of internal value chain; 2) analysis of flow of goods and total value created by the extended value chain; 3) identification of ways to increase the amount of value created by the extended value chain; 4) configuration of network around identified opportunities of value creation; 5) identification of ways to capture value created; 6) management of cross-industry value chains. Lately, using four empirical cases, van Heck (2006) empirically validated that network orchestration together with distinctive and leveraged capability building, as proposed by Hagel and Seely Brown (2005), are crucial for the success of business network. He identified four types of orchestration, namely, platform orchestration (eBay), design orchestration (ZARA), mar-
ket making orchestration (Brazil Holambra flower auction) and government driven orchestration (China Kunming flower auction).

3. CONCEPTUAL FRAMEWORK

As customers are the key to the success of business network, when evaluating the performance of business network, the customer dimension has to be incorporated. We adopt customer relationship dimension of the ‘relationship centered organizations framework’ that developed by Gulati and Kletter (2005). This framework encompasses multiple facets: transaction, enhancement, investment and ownership. On the customer dimension, these four facets are represented by the following four levels in the customer relationship ladder.

- **Commodities**: On the lowest level, a customer spot buys undifferentiated products and services based entirely on price and term.
- **Branded offering**: Up one level, a customer is purchasing based on known relationship with a product or service, but not based on relationship with the seller.
- **Loyalty**: On the next level, a customer and seller have invested mutually in a relationship, creating a bond of loyalty between the parties that transactions individual product or service offerings.
- **Solutions**: Finally, at the top of the ladder, the seller takes ownership for solving a customer’s problem by creating offerings with a higher value proposition. Here the seller takes ownership for success of a portion of the customer’s business, offering a solution to a problem that the customer faces, and receives compensation not based on the volume of products or services, but on a successful outcome from the customer’s standpoint.

Evidences show that winning firms are striving to improve customer relationships, among others, scholars have found, information sharing with the customers is considered as the utmost important task by the organizations who are climbing the customer relationship ladder (Gulati et al., 2005). Information sharing means two-ways in terms of direction of information flow: information pull and information push. Information pull is organizations retrieving information from their customers, while information push is the ability of organizations to provide information to their customers.
Each of these four levels will be analyzed and validated with the case of Octopus in the following sections.

4. EMPIRICAL CASE STUDY -- OCTOPUS

**Evolutionary Development of Octopus**

Founded in June 1994, Octopus, a smart card used in Hong Kong, is by far the world’s most successful contactless smart card with over 13 million cards now in circulation and over 9.2 million transactions each day amounting to a total of US$ 3 billion a year. With the idea of developing an automated fare collection system based on contactless smart cards, Hong Kong’s underground railway operator Mass Transit Railway Corporation (MTRC) together with four local public transportation operators (KMB, Citybus, Hongkong and Yaumati Ferry) formed a joint venture company, which is later named as Octopus. The card was introduced to the public in 1997 and was quickly expanded to other transport services. Hong Kong Monetary Authority granted a deposit-taking company and removed previous restrictions that prohibited Octopus from generating more than 15% of its turnover from non-transit related functions. In January 2001, Octopus Cards Limited (OCL) was transformed from its previous non-profit making organization to a profit making enterprise (Octopus, 2006).

In 2000, Octopus entered various retail markets. Many stores in the city are all accepting Octopus, most notably, 7-Eleven, McDonald’s, convenience stores, other fast food restaurants and Starbucks coffee shops. Continuing the expansion, Octopus successfully replaced all Hong Kong Government’s 18,000 parking meters with a new Octopus card operated system in 2004. It further expanded to government facilities including public swimming pools and sports facilities. Not only aggressively expanding in its home base in Hong Kong, Octopus also succeed in winning cross-border contracts to mainland China and successfully built its first overseas business expansion – the Netherlands, with a $25.64 million contract for providing Octopus-like smart card technology. Today 95% of the population aged 16-60 possesses the card, over 130 service providers accept Octopus and over 50,000 Octopus processors are in use over Hong Kong.

Acting as a network orchestrator, Octopus actively expands its business network in the last decade, which we call “Octopus evolutionary network” is illustrated in Figure 1.
“The core values of our business are to create a trusting and encouraging environment for customers, staff and shareholders whereby we can communicate, collaborate, share and support each other as equal partners. Continuously innovate, seeking better ways to conduct business and creating new opportunities. Strive to delight customers whenever they encounter Octopus. Our mission is making everyday life easier by applying innovative ideas through secure and robust technology”.

Methodology

Case study research is chosen to empirically validate the conceptual framework and propose propositions as it investigates a contemporary phenomenon within its real-life context (Yin, 2002). The rationale for selecting the single case - the evolutionary network of Octopus in Hong Kong - for its being unique (Yin, 2002). Unique in the sense that it is the first (and only) network leader in the world that enjoys the breadth and depth of the remarkable success in a large-scale micro electronic payment adoption.

Data was collected through personal interviews, documents, websites and previous researches. Taking the full strength of the case study method, this data collection approach also tries to enhance the validity of the research. In total, several interviews were carried out with managers from strategy, marketing and operation at Octopus, MTRC during a visit in Hong Kong, and people at different management levels in Netherlands Railways.
Figure 1: Octopus Orchestrates its Evolutionary Network
5. ANALYSIS

What are the stimuli that trigger various service providers and customers to become members of Octopus’ business network, in such a large scale and in such a fast pace? What are the factors that attributed to this remarkable success of Octopus? With the help of the conceptual framework, in this section, we firstly analyze the benefits of smart card adoption and then discuss the factors attributed to Octopus’ success, which leads to a win-win-win situation.

Benefit of Smart Card Adoption

Why do so many service providers partner with Octopus? What are the benefits for service providers? And for customers? We limit our benefit analysis for smart card adoption to only transport sector before Octopus expanded to non-transport industries. We first take transport operators’ standpoint. In assessing the effect of investment in ICT on the business performance of an organization, Parker and Benson (1988) argued that it should be evaluated on both reducing costs and producing revenues. Therefore, when an ICT initiative (smart card enabled electronic ticketing) is being considered as a means to improve business performance, both sides of the coin, namely, costs and revenues should be considered. From cost perspective these benefits include:

- **Cost saving.** Savings in operating cost through acceleration of ticket purchase and reducing unnecessary clerk work.
- **Simplification of cash handling and control** through electronic payment. On one hand, because all micro payments are made electronically, it increases the safety of drivers for not handling large amount of cash during operation.
- **Revenue apportionment.** Previously there is limited overview on how much revenue each transport provider makes because the data on the accurate patronage is not available. After the Octopus, all transport operators link their computer networks to the Octopus’ data clearing house, which does revenue apportionment and fund transfer.
- **Operation efficiency.** Based on the more accurate information on the travel demand from origin to destination, the transport operators could make more precise decision on the number of transport vehicles to dispatch.
• *Reduce the staff handling cost and improve the staff utilization.* Knowing the amount of the travelers at nearly the real-time would allow transport operators to dynamically allocate conductors. For example, on the more congested vehicles.

• *Less need to carry out statistical surveys.* Conducting survey, especially nation-wide travel behavior survey, requires big efforts and spans long period. The smart card data could be very well served as a complementary method to, if not replacing the current time- and money-intensive survey study.

From revenue perspective the benefits are:

• *Improvement in cash flow.* Revenue received in advance is equivalent to a saving of interest on short-term borrowing.

• *Access control.* Electronic gates are able to control the travelers’ access, keep the black riders out of the transport system, and hence reduce the travelers’ fraud levels.

• *Flexibility in fare product and tariff structure.* The data collected through the electronic ticketing allows the transport operators to understand more about their customers and, hence, offer better fare products and design more appropriate tariff structures.

• *Travel management.* The smart card data could enable transport operators to make a link between the trips made and the individual travelers, if the card is not an anonymous one. Thus, transport operators could understand more about their customers’ travel behaviour and enhance their capability on travel management through appropriately designed travel management system. This form of management is similar to that of many other modern consumer goods.

• *Providing value-added services.* Providing various transport companies involved with improved information management capabilities, it is also important to note that the smart card offers numerous opportunities for the value-added services. For example, linking smart card to traveler’s mobile device could allow the operators to not only send the real-time travel disruption information at the point of travel, but also the possible congestion situation of the chosen route.
Besides the positive influences at suppliers’ side (e.g., transport operators) on costs and revenues, which may be passed on to customers, customers also experience the following benefits:

- **Seamless multi-modal traveling.** Travelers in Hong Kong used magnetic tickets for subway transport before Octopus, however, the other modes still require different means of payments (e.g., coins). Using smart card significantly increased the convenience of multi-modal traveling.

- **“Touch-and-go”**. The smartness of Octopus card exists in its contactless. Different from contact cards or slot-based cards, with Octopus card, travelers can simply place their cards (even in their wallet or purses) in front of readers in proximity. This largely improves the processing efficiency and convenience.

- **Increasing social safety** in public transport and reducing fare evasion.

- **Speed-up journeys**. Travelers would appreciate that the smart card can offer new functionality and speed up journeys by reducing ticket purchasing queues and transaction time.

- **New infrastructure** – electronic gate and Ticket Vendor Machine (TVM). Travelers experience a new set of infrastructure, for example, TVM that co-exists with the staff operated windows.

All of the above mentioned benefits are summarized in Fig. 2.
Factors Attributed to Octopus Success

Using smart card technology to replace cash was not new in Hong Kong. Major credit card operators and financial institutions including MasterCard (Mondex) and VISA had been trying to capitalize on such business opportunities since late 1980s (Chau & Poon, 2003). In fact Mondex launched its own card even one year before Octopus in 1996, however, withdrew from Hong Kong market in 2002 even though it has solid backing such as HSBC. This is mainly due to the fact that the widespread popularity of Octopus has originated from the public transport commuters and the convenience it has (e.g., contactless card, low cost). Extending the previous research (Chau et al., 2003), we identify the following factors that account for the success of Octopus.

- High demand for transport services. The 1980’s witnessed a large-scale transfer of industrial activities from Hong Kong to the Pearl River Delta in Guangdong Province, China and the re-emergence of trade as the Territory’s economic base. As a consequence, there is a increasing separation of the residence from the work place, which
results in substantial increase in the demand for transport services of all kinds.

- **High transaction volume.** On one hand there is an increasing demand for transport services, and on the other hand expensive fuel and maintenance cost as a result of high import tariff make the car ownership impossible for most of the Hong Kong residents. Three quarters of the 7 million Hong Kong residence use public transport commute between home-work/school. This provides a large customer base for Octopus and therefore lays a good foundation for creating a critical mass at the initial phase of the introduction.

- **Quick service.** Compared to a contact card which requires 5 seconds to process, Octopus has reached a 0.3 second processing time. According to a survey conducted by University of Auckland (Chau et al., 2003), this quick service has attributed to the major success of Octopus.

- **Low entry barrier.** Before Octopus, Hong Kong people used magnetic card for some part of the public transport. They have used to the stored-value ticketing concept and entering the stations via electronic gates. Hence, it is relatively easier for people to switch to Octopus, which is just another media for micro-payment.

- **Customers’ loyalty.** From the experience of using magnetic card, Hong Kong people have used to travelling with micro-payment card. They have enjoyed the convenience that Octopus provides for travelling seamlessly through all modes of transport with only one card. This helps gradually build loyalty to Octopus, which lays foundation for other value-added service operators to participate.

- **Trust among Octopus stakeholders.** MTRC takes the leading role at the beginning of the Octopus implementation phase. This is extremely important for deploying a sector-wide system, because it provides guidelines and standards for the other public transport operators to adopt this technology.

- **Auto-recharge capability.** Forming alliances with banks and credit card operators, Octopus develops its automatic recharging capability, which enables customers to automatically recharge their smart card whenever the balance goes to zero. This has tremendously reduced the frequency and hassles of recharging the card.

- **Direct conversion.** 3 million cards were issued within the first three months after launching. The main reason attributed to the large adoption at the beginning was that MTR and KCR required that all holders of magnetic card replace their tickets with Octopus in three months or have their cards made obsolete, thus “forcing” their
combined nearly 3 million commuters to switch quickly to Octopus.

**Win-Win-Win Situation**

Who wins in this massive adoption?

- **Octopus (network orchestrator) wins.** Octopus’ net profit rose to HK$68.8 million in 2005 from HK$39.4 million the previous year. Turnover reached HK$207.1 million, up from HK$176.7 million. Therefore, as a network orchestrator Octopus wins.

- **Network member wins.** As discussed, it is beneficial for transport operators to adopt smart cards. Joining the business network of Octopus reduces the costs of doing business for individual actor, thus network member wins.

- **Customer wins.** In 2005, Octopus has established Octopus Rewards Limited that fully responsible for the development and operation of the rewards program. With close collaboration with different merchants, Octopus offers all card holders rewards regardless of the payment means by means of instant redeeming across industries. Customers enjoy among others, low cost, increased convenience and additional rewards, hence, customer wins.

**6. OCTOPUS CLIMBING CUSTOMER RELATIONSHIP LADDER**

In this section we summarize Octopus network strategy while it is climbing the customer relationship ladder (details see Table 1). Presenting a networked transport vision from customers’ perspective, we claim that it will enable network orchestrator (e.g., Octopus) to move to the last level of the ladder -- establishing ownership to the satisfaction of customers.

Firstly, Octopus is a commodity (reaching critical mass). In 1997 Octopus went public, replaced magnetic card and became the micro payment system that used by a small number of public transport operators. However, it quickly received its popularity and established a solid foundation for the further adoption.
Secondly, Octopus becomes a branded offering (integrate all modes of transport). In 2000 Octopus was widely used by almost all public transport providers and enabled travelers to go seamlessly to nearly all modes of transport by a single smart card.

Thirdly, Octopus strives to get loyalty (full payment intermediary with reward system). In 2003 Octopus expanded to a large number of non-transport services, and quickly established businesses in mainland China and abroad. Expanding to value-added businesses, Octopus grows its business and at the same time shares its profit with the customers. In 2005 Octopus established a business unit implementing customer reward programs. A reward program can accelerate the loyalty life cycle, encouraging first- or second-year customers to behave like a company’s most profitable customers. Researches have suggested that a company must find ways to share value with customers in proportion to the value the customers’ loyalty creates for the company (Obrien & Jones, 1995). It is important to note that by investing in ‘customer reward scheme’, Octopus builds customer loyalty and moves to the investment stage of the relationship ladder.

<table>
<thead>
<tr>
<th>Relationship Ladder</th>
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<th>Octopus Service Expansion</th>
<th>Octopus Network Strategy</th>
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<tbody>
<tr>
<td>Transaction</td>
<td>Conformity</td>
<td>- Replacing magnetic card with smart card.</td>
<td>Reach critical mass</td>
</tr>
<tr>
<td>Enhancement</td>
<td>Branded offering</td>
<td>- Octopus smart card enable customers to travel seamlessly through the entire public transport.</td>
<td>Integrate all modes of transport</td>
</tr>
<tr>
<td>Investment</td>
<td>Loyalty</td>
<td>- Octopus expanded business to many non-transport industries; - Build customer loyalty, Octopus implements “customer reward scheme”.</td>
<td>Full payment intermediary with reward system</td>
</tr>
<tr>
<td>Ownership</td>
<td>Solutions</td>
<td>- Establish ownership to the satisfaction of customers; - Offer customized solutions; - Focusing on the individual customer and his/her individual requirement preference;</td>
<td>Become Octopus identity card</td>
</tr>
</tbody>
</table>

Table 1: Octopus climbing customer relationship ladder

Octopus is standing at the investment stage of the customer relationship ladder. Recently, Hong Kong SAR Government has announced a plan to replace its existing plastic Hong Kong identity cards with smart card-based identity cards with the capacity to support multiple applications. Octopus has the full potential to become an identify card of Hong Kong people (Chau et al., 2003). The early prediction on “one day all plastic cards will meld into one universal, multifunctional smart card” (Shelfer & Proccaccino, 2002) seems becoming true soon, at least in Hong Kong.
Fourthly, Octopus should establish ownership to the satisfaction of customers. Previous research has shown that there is a pronounced shift from selling products and services to providing integrated solutions (Gulati et al., 2005). Product-based differentiation is more costly and difficult to maintain than ever before, and product differences are increasingly meaningful. Diverse industries are looking for opportunities to differentiate by developing higher-margin “solutions” business. Gulati et al. (2005) claim that a true solutions relationship is that value is not reapportioned but rather new value is created, and shared. Solution is a supplier’s customized response to a customer’s pressing business needs. Hence in structuring solutions, Octopus will need to focus on creating individualized solutions based on, for example, individual customer’s history, requirement or preference, and establish performance monitoring metrics that will both measure gains and distribute them to customer. We illustrate this idea in the next part in the form of presenting a networked transport vision.

**Networked Transport**

Travel is significantly a discontinuous experience for most of the customers. Reasons are threefold. Firstly, different modes of transport are owned by different transport operators. For example, bus, subway, railway, taxi roads, etc. are most of the time operated by different organizations. This requires customers to “contact” multiple parties for the entire journey. Second, they all have different operational standards and different means of payment, which might result in confusing pricing for customers. Third, different modes of transport have different information sources. All in all, there is little ownership of the customers’ entire journey. In order to create ownership to satisfy customer requirements, it is important to have a customer oriented thinking and design a solution that integrates infrastructure network, information network and process (details see Table 2).
7. LESSONS LEARNED

The empirical validation of the conceptual framework leads to a number of lessons learned in the form of propositions. These propositions focus on three aspects: network strategy, networked IT infrastructure and network structural holes (illustrated in Figure 3).

Propositions

Proposition A: Network strategy (customer network). Climbing customer relationship ladder, the focal firm expands its customer network to gain sustainable competitive advantages.

Creating convenience for customers and reducing costs for service operators to do business, Octopus soon receives its widespread popularity and quickly scaled up. The success of Octopus is in fact a result of network effects. Various service providers ensure that their payment systems are compatible with Octopus in order to have access to the large market of Octopus users. On one hand, Octopus is popular because it is well supported, on the other hand it is well supported because it is popular. This finding coincides with earlier research on effects of network strength in terms of installed customer base on firm performance (Shankar & Bayus, 2003).
Shankar and Bayus argued that a firm’s customer network is an important strategic asset. As resource-based view suggests that how the firm uses its assets is a key determinant of a sustainable competitive advantage. The case of Octopus demonstrates that from commodity to branded offering, from loyalty to solutions, the higher a firm climbs up the customer relationship ladder, the more it creates sustainable competitive advantage.

Proposition B: Network IT infrastructure (information network). A networked IT infrastructure will lead network orchestrator to employ information pull and information push strategy in real-time.

Advanced technologies have provided networked IT infrastructure for information sharing. For example, GPS, RFID, customer relationship management (CRM) system could be designed to track what each customer purchases and when. Using these data, firms should be able to determine the probability that a given existing customer with a certain buying history will purchase a given product at a given time. This information should enable firms not only to target the customers who are most likely to purchase something but also to tailor their offering to what is most likely to appeal to them (Kumar, Venkatesan, & Reinartz, 2006). Let’s illustrate this with examples from transport sector:

- “Information pull”. Transport operators could retrieve information to understand better of their customers in terms of where they travel to and from and at what time. This will help to tailor their services better to the requirements of their customers;
- “Information push”. Integrating the information locked within the public transportation system’s own databases and then pushing it out to riders via mobile devices or street-side kiosks; linking not only the transit systems of a single city but also of an entire region or country;
- Real-time. Provide customer accurate real-time information on the move. In this scheme, transit systems would abandon rigid schedules in favor of more adaptive, ondemand services;

Proposition C: Network structure holes. For a nation/region-wide adoption of smart card, a network orchestrator creates a structural hole with networked transport, which will eventually lead to networked business.
The true benefit of smart cards to the customer in general will not be apparent until the volume of smart card reaches a critical mass. Critical mass is the point where merchants feel they need to accept the cards to avoid losing potential customers who would go to another service provider because they do not carry cash to make purchase (Turban & Brahm, 2000). This inevitably enables Octopus to create a structural hole (Burt, 1992) in its network. According to Burt (1992), structural holes create a competitive advantage for an individual whose relationships span the holes. The firm occupies the structural hole, thus, has the opportunity to broker the information between actors, control the processes that bring together firms from opposite sides of the hole, and have the autonomy in the complex network. Recently scholars from strategy perspective have argued that network structures and positions of focal firms in a network have significant effects on firm performance (Gulati, Nohria, & Zaheer, 2000; Zaheer et al., 2005). Building on a networked transport, Octopus benefits from occupying structure holes, which will inevitably span and lead to a networked business.
Implications for Dutch transport industry

Smart card based automatic fare collection systems are being introduced all around the world. Singapore’s “EZ-Link” card reaches a 5 million user base since 1999. Transport for London (TfL) adopts “Oyster” card on its London bus system that covers tube, bus, trams and national rail services, and have attracted 7 million users. Prepared for the Olympic Games in 2008, Beijing introduced smart card on 10 May, 2006 and had 1.5 million first-day adoptors.

Being Octopus’ first oversea expansion, the Netherlands plan to use smart card and readers’ technology to create an all-encompassing contactless ticketing infrastructure. At full implementation the system will have to contend with an estimated 1.5 billion transactions each year. In 2002, Trans Link Systems (TLS) was established by five major public transport operators in the Netherlands responsible for the coordination of the smart card adoption. These five companies are Netherlands Railways (NS), Connexxion (bus), GVB (Amsterdam), HTM (The Hague) and RET (Rotterdam), together they provide 80% of public transport in the Netherlands.

Focusing on the outcome of the analysis, the following six trends are identified with regard to the smart card adoption in the Netherlands.

- **From decentralized network to orchestrated network.** As we learned from Octopus case, network orchestrator has a significant role in specifying interoperability, standards, framework to ensure the trust, collaboration, as well as accurate and timeless delivery of the data.
- **From single mode of transport to end-to-end multi-mode facilitation.** End-to-end facilitation of multi-modal journey and travel services (bundled with other services) to deliver integrated services.
- **From multiple sources to one touch point.** Provide travelers information on searching, booking, payment and ticketing at one single point of touch.
- **From information pull to information sharing (pull and push).** To give more and more benefit to customers, a winning firm will increase the information sharing with its customers.
- **From off-line and delayed information to online and real-time information.** Provide travelers with real-time vehicle information on delays and changes.
- **From generic treatment to customized solution.** Focus on the individual customer and his/her specific journey. Smart card can con-
vey the individual behavior to business, coherently and with repeatability at every touch point.

Although similar in general approaches comparing to Octopus, there exist a number of obstacles for the adoption in the Netherlands. This is mainly because of the specific technology and/or culture characteristics. On the technical side: The transport network in the Netherlands is more complex than in Hong Kong, not even taken into account of the bus, tram and metro, the railway network itself has nearly 400 stations comparing to 30 stations of Hong Kong subways. This means more stations have to be gated and more money has to be invested. Also due to the long distances of each journey, potential threads of the fare fraud could also reach a different level. On the social side: European cultures are different from Asian cultures in terms of customers’ perception and comfort with new technology. The entry barrier might be bigger in the Netherlands than in Hong Kong. Two different micro payment systems are in use today in Dutch market, ‘chippen’ and ‘pin’, which might create certain barrier to the ‘OV-chip card’ introduction. It might well be the case that people are not used to the electronic gate or stored-value ticketing concept, thus there will be resistance towards changes to some extend. Last but not least is the concern of security and privacy, even though some security aspects already build into the technology, it takes time for people to build trust, and feel safe of being billed properly.

8. CONCLUSIONS

Return to the first research question: How do business networks sustain a “win-win” situation for both customers and network members? Using the evolutionary network of Octopus that developed in the last decade, we have empirically validated our conceptual framework. The following conclusions are drawn from this research:

- Customers’ benefits are important when evaluating the performance of business network. Satisfying customer needs and building value-added services should be the primary focus of a firm as well as a business network. Octopus case empirically validates the conceptual framework that developed by Gulati and Kletter (2005). Climbing customer relationship ladder, the focal firm expands its customer network to gain sustainable competitive advantages.
• A key elements for reaching a critical mass of users is interoperability that orchestrated by a network orchestrator. The interoperability is more than just technical standards and administrative framework, but should be considered in multiple levels. We have discussed the customer’s requirements in having integrated infrastructure, integrated information and integrated processes.

• It is significant to provide justification of benefits, tangible and intangible, to the business members. Service providers will only participate when they perceive a clear justification of joining a business network.

• For a nation/region-wide adoption of smart card, a network orchestrator creates a structural hole with networked transport, which will eventually lead to an all connected ‘smart business network’.

The focal point of this study has been on customers, a next step in this research could focus on other aspects of the ‘relationship organizations’, suppliers, alliances and internal sub-units. This will help us establish an overall assessment of the true success of Octopus as well as its business network, both in the short-term and in a more sustainable manner.

The second question is: what are implications for the Dutch transport industry? We have identified six trends in the future development of smart card adoption to the Dutch transport industry. And we have also discussed a number of challenges because of the specific characteristics of the Dutch transport market and European culture in general. However, it is not clear whether the same success will happen again, and whether TSL will be able to span its structure hole and become Octopus of the Netherlands. Therefore, it is our future research to trace this development, and compare cases from different countries / continents, in order to draw more generalized conclusions.

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27. Real-time Communication and Virtual Organisations: Technical Affordances and Technology-in-use

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Abstract

This paper introduces Real-time communication (RTC), a new communication services, which has been developed and implemented over the last couple of years. Specifically, using a dual approach of reflecting affordances of RTC and scrutinizing individual and social processes of appropriation and shaping the technology-in-use, an exploratory Delphi study was conducted in order to see how RTC is interpreted by experts. Afterwards, three case vignettes of virtual organisations (VO), illustrating different outcomes of RTC-in-use, are selected and described. The paper concludes that while at first glance, the affordances of RTC seem to fit VO, sense-making about RTC should primarily happen within a rich organisational setting.

Keywords: Real-time Communication, Delphi study, Virtual Organisations, Affordances, Technology-in-use

1. Introduction

Over the past years we have observed a profound transformation of the organisation and practices of work: most prevalent is the increase of distributed and networked forms of work within and across organisations [cf. 1,2,3]. The distribution of work has extended degrees of freedom in terms of place and time of work – telework has significantly increased over the past years – while maintaining a high level of connectedness and access to remote work environments [4]. In parallel, the availability, bandwidth, richness and diversity of communication technologies and services has increased tremendously. Partly enabled or even driven by the proliferation of
information and communication technologies and infrastructures, the emerging forms of organising, work, social life, learning and information sharing are communication and coordination intensive. These trends have lead to a situation, where individuals (especially knowledge workers) enjoy the wealth, connectivity and low cost of technologically mediated communication and at the same time are increasingly suffering from a rising wave of communication devices, services and – most importantly – communication events. Daily work becomes ever more fragmented and just managing the onslaught of messages takes an increasing amount of time [5,6]. This trend is critical, as knowledge workers take up a central role for today’s organisations. They provide intangible assets and resources, which are crucial for organisations’ competitiveness and success [7]. As organisations become more reliant on such intangible assets, structures of organising are likely to shift from hierarchies to network forms (ibid.). With companies increasingly relying on distributed project teams and knowledge workers, their productivity becomes of paramount importance.

Groupware has been promised as a form of information and communication technology which facilitates dispersed and virtual forms of organising (collaborative claim). In a nutshell, the collaborative claim alleges that groupware allows, first, access to structured information, and, second, more efficient and democratic forms of collaboration as communication within and across organisational groups is increased by facilitating social relationships [8]. However, the collaborative claim fails to explain the contradicting outcomes of ‘groupware-in-use’ [9]. To overcome this shortcoming, one promising research direction is to take Orlikowski et al.’s [10] appeal for a thoroughly theorization of information technology more seriously. Following her advice, Kelly [11] argues that groupware distinctively shapes the quality of interaction through making reifications of communication persistent, reproducible, aggregatable, and accessible regardless of one’s physical location. Groupware mediated interaction is therefore distinctively different from oral communication which rather consists of reified sound produced by human voices. Groupware requires people to actively engage in inscribing representations of their experiences. These processes of creating representations do not only involve additional effort but they also place limits on how much of a person’s experiences can be usefully represented. Reflecting these limits, Kelly argues that theorizing groupware is not tantamount to falling back into a technological essentialism, i.e. technical attributes deriving from the internal characteristics of the technology [12]. Rather, combining considerations about the materiality (and affordances) of technology with social relations within which technology is embedded may give insightful accounts for the contradicting
empirical findings of groupware. We will use this dual approach of reflecting affordances of emerging technologies and scrutinizing individual and social processes of appropriation and shaping the technology-in-use.

In the remainder of the paper we will focus on real-time communication (RTC) technology (section 2), a new genre of communication services, which has been heralded as a solution to many of the problems of virtual forms of organising. We will report results of a Delphi study, which was designed to reflect technological affordances and organisational implications of RTC. As the experts’ feedback emphasised the need to reflect specific contingencies of the RTC use, we will focus in section 3 on virtual organisational settings and have selected three case vignettes, which illustrate profoundly different outcomes of RTC-in-use.

2. Real-time communication

In response to both, the complexity of today’s working environment and the increasing diversity of communication services and devices, a new genre of communication services, called real-time communication (RTC), has been developed and introduced. RTC integrates synchronous and asynchronous forms of communication, and emphasises verbal forms of communication. In this way, RTC mitigates some of the drawbacks of earlier groupware solutions, which involved creating explicit, written representations of experiences. RTC intends to re-establish (or maintain) the link between the documentation of work and the originators or experts behind it. Rather than creating almost anonymous repositories of knowledge, a large part of documents remain embedded in processes of discourse, interpretation and joint sense making. The human remains in the loop.

Riemer and Frößler [13] identify four building blocks of RTC technology, namely unified communication, presence awareness, collaboration portfolio and contextualisation. Resulting from market convergence, RTC has its roots in both the telecommunications market and the market for groupware systems. RTC systems are therefore a combination of well-known features such as Voice-over-IP telephony, instant messaging and various groupware and eCollaboration features. Based on the idea of unified communication (UC), which describes the computer-supported combination and management of communication channels according to user preferences, RTC overcomes the traditional distinction between either synchronous or asynchronous technologies as both aspects are integrated within one application. However, the provision of status information regarding the availability of the user and his media and communication de-
Real Time Communication (RTC)

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<th>Presence Awareness</th>
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<td>Media and device integration</td>
<td>Aggregation of presence awareness information on group, role, and object level</td>
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</tr>
<tr>
<td>Team calendars and contact management</td>
<td>Mobile RTC with location-based services</td>
</tr>
<tr>
<td>Document folders</td>
<td></td>
</tr>
</tbody>
</table>

Figure 15: Building blocks for Real-time Communication and Collaboration (adopted from Riemer et al. 2006)
2.1 Research Design

As RTC has been introduced quite recently and provides a versatile set of functions and services, it is difficult to judge its impact – positive and negative. For that reason we have decided to do an exploratory Delphi study in order to see how status and trajectory of RTC are perceived by experts.

Since the Delphi design was developed during the early 1950’s by the Rand Corporation [14], it has been applied in different domains - among others the education sector, tourism and business industries, politics, health sector - and addresses a myriad of issues, such as sales forecasting, technology planning, policy formation, market research [15,16]. Over the last couple of years, the Delphi design has also been used within the information systems discipline [cf. 17,18,19,20], with most of the studies being used for forecasting, issue identification/priorisation or concept/framework development [21].

To date, the number of definitions of what a Delphi study is and is about is almost as large as the number of studies that exist and so is the number of different views on the “best” and/or “useful” procedure [16,22]. However, the classical Delphi design shares the following characteristics across the varying definitions: application of formalized questionnaires, panel of experts, responses of each single expert are kept anonymous, determination of the statistical group response, and two or more rounds [22]. Häder [23] identifies four different objectives of Delphi studies which influence their design, namely Delphi studies for (1) aggregating data, (2) making as exact predictions as possible about uncertain events, (3) determining and qualifying experts’ opinions on diffuse issues, and (4) building consensus.

The RTC Delphi study belongs to type three as its objective was to determine and qualify experts’ opinions on the current situation and future trends of RTC. It has targeted a group of experts whom we can assume have a familiarity with the subject area and most technical terms. Nonetheless, in the introduction of the study the broader context of the subject area was described and a tentative explanation of RTC was given. As RTC has not been clearly defined nor distinguished from other ICT, embedding the discussion within a broader discourse is crucial to create a shared network of meaning. The questionnaire contains both descriptive and predictive/future oriented parts. Questions are grouped in relation to three areas, namely individual, organisational and domain specific aspects. Reasoning fields after almost every question allow experts to share the rationale of their decision or to mention other issues related to the particular question.
The selection of experts is a critical stage of Delphi studies as experts’ professional and institutional background influences their views and interpretations of the subject matter and consequently the results of the study. A necessary prerequisite for a person to be nominated for the panellist was to be expert in the area of RTC. However, as to represent different points of view, the group of experts was further subdivided into three distinct groups, namely academia, technology providers and users. Consultancies and companies which had already experience with using the technology were part of the latter group. All in all, 40 experts were selected and asked to participate in the study, with 10 coming from the technology provider group (25%), 15 from academia (37.5%) and 15 from the user group (37.5%). Out of the 40 experts, 16 experts finally agreed to take part in the Delphi study (40% response rate), with nine coming from academia, four represented the user group and three the technology providers. One expert dropped out after the first round leaving the number of experts who participated in the second round at 15 (93.75% response rate).

The first round contained both open/qualitative questions and closed/quantitative ones. The qualitative questions of the first round were evaluated with answers being consolidated and terms being standardized as far as they addressed similar aspects. The resulting list of items was then used to forming quantitative questions that were included in the second round of the Delphi study. The quantitative questions were either feed back as graphical representations of the aggregated results, depicting the median, the upper and lower quartile, and the maximum and minimum values (this representation was chosen for all questions using a Likert scale). However, for those questions deriving from the qualitative inquiry of the first round, panellists were asked to rank the five most important items and the average mean was calculated accordingly. The Delphi study was terminated after two rounds due to theoretical [24] and practical [16] considerations.

2.2 Findings and discussion: New forms of social interaction in networks

While knowledge workers often need immediate access to information, their skills are at the same time very much in demand which is why they have to cope with frequent interruptions. Current technologies such as the mobile phone reduce communication delays for the initiators but often translate into interruption on the part of the recipient [6]. In order to avoid constant availability and interruptions, people may employ tactics, such as not answering the telephone, working away from one’s desk, and setting their availability status flag to “away” or “busy”.
However, rule-based forwarding of communication requests and self-service portals as offered by RTC might balance the partly conflicting demands of initiators and recipients and may bring about new forms of interaction. Experts were therefore asked to assess RTC’s potential to a) help initiators to obtain time critical information, b) help recipients to manage interruptions more efficiently and c) help both parties at the same time. Asked about RTC’s potential to provide initiators with a tool to access time critical information, all experts are convinced that RTC might help people to reduce delays by swiftly accessing information providers. On the other hand, experts are slightly more sceptical about RTC’s potential to manage interruptions (60% of the experts strongly agree or agree), and to help both initiators and recipients to the same extent to deal with an increased communication volume (66.7% of the experts strongly agree or agree). One expert remarks that although RTC might lead to higher efficiency, it won’t change managers’ predisposition towards communication and they will continue communicating most of the time. Panellists richly substantiated their critical evaluation with several comments. First, as one expert argues, RTC will generate more communication volume as “some topics, you otherwise would not discuss are facilitated by RTC. (…), i.e. the more possibilities the more communication. This does not mean that the communication gets ‘richer’”. Second, it is pointed out that in co-located settings, users might circumvent filtering mechanisms of RTC just by popping up at someone’s desk. Third, one panellist points out that interruptions in form of outeraction [25] are needed as to negotiated availability. RTC therefore needs to authorize different forms of interruptions for negotiating availability. Finally, another expert questions whether RTC applications will be handled by all users in a way that will ensure the envisaged results. “Organisational issues which are much more important than the technology in the success of the whole information system” need to be taken into account as well. Several panelists maintain that RTC, like any other technology, is a double-edged sword; depending on the organisational aspects mentioned before, RTC can either help users to manage interaction but also result in increased visibility, accessibility and interruptions.

With the intensification of globalisation, enabling the transmission of verbal and non-verbal information and the extension of organisations across time and space [cf. 26], virtual forms of organisation have become ubiquitous. However, reported drawbacks of dispersed forms of organising are among others a lack of mutual awareness [cf. 27], exclusion of the core community [cf. 28], or simply the shortcoming to facilitate collaboration [1,29,30]. Asked to assess the claim whether RTC has the potential to sup-
port geographically dispersed collaboration, 93.3% of the panellist strongly agreed or agreed. Awareness information which signal team members’ availability was explicitly mentioned as one factor that might facilitate virtual collaboration. However, with a view to delays, interruptions and communication volume, one expert remarked that while RTC may facilitate dispersed work, it will be achieved at the cost of interruptions. Others argue that whether RTC adds or reduces complexity will depend on the individual and team routines. Finally, one panellist maintained that as not to actually increase the complexity by adding another channel, RTC has to be properly integrated in the existing ICT infrastructure.

As team members are recruited based on their expertise and capabilities rather than local availability work among people with diverse social, cultural and professional backgrounds is today commonplace [cf. 31,32,33]. Experts are cautiously optimistic (60% agreement) that RTC can have positive implications on facilitating collaboration in diverse settings. It is argued, that e-mails are especially prone to misunderstandings in diverse settings where fast clarification is crucial to resolve issues as early as possible. RTC is perceived as a potential application that enables fast intervention as to deescalate problems. As to ensure that RTC lives up to its high expectations, rules and norms were identified by the experts, which are needed to ensure proper use. Norms should be developed concerning the availability status, e.g. when is it appropriate to interrupt someone although the awareness information signals ‘do not disturb’. It is suggested that senior management should take the lead through frequently using rules in well known circumstances and new hires should be introduced to these rules from the outset. More pessimistic voices are brought to the fore by others who remark that communication behaviour depends on an understanding of cultural backdrops which can not be overcome via rules or norms. Face-to-face meetings and phone calls will still be needed as to resolve discontent within groups. In addition, the acceptance of RTC might depend on the professional background with software developers for instance being more willing to using RTC than professional groups which generally show a more averse aptitude towards technology.

As to better appreciate the role of social relations and support needed to bring about efficient collaboration among knowledge workers, experts were asked to first name and then rank factors that do (or might) impede organisations to utilise RTC to its full potential. Interestingly, although the question was not limited to social issues but could also contain technological or legislative aspects, social issues were by far the most important ones. First, experts raised concerns that the existing work practices within organisations will constrain the use of RTC. Partly related to this issue, users might emotionally reject RTC as they fear privacy/ control issues, loss
of power, or a threat to their positioning within the firm. However, one panellist mentioned that while privacy issues “are always a problem in the beginning, the interpretation of technology as a threat can change over time”. As one expert remarked “control will be a problem, especially if management begin to use RTC to discipline staff”. The third aspect addresses the concern that RTC might not come up to its full potential if it is not properly integrated within the organisational context. As one expert suggests “The base technology is there, but is far from effectively integrated in organisational context. Management practices do not yet understand the issues and know how to productively deal with them”. Finally top-management support or security concerns are not interpreted as major issues.

The final question which explicitly addressed means as to increase the acceptance of RTC in organisations, identified the management as taking up a central role. A controlled, top-down oriented management style, training users how to use RTC efficiently, encouraging users to continuously adapt RTC to their specific needs, and tightly integrating RTC in work process are all areas where experts believe management is required. Contrastingly, panellists are less convinced by the potential of democratic/consensus driven management styles to overcome resistance nor seems a laissez-faire policy which leaves it to the users how to adopt and appropriate RTC a promising approach. However, one panellist disagrees with the outlook of most experts and argues that “RTC is often a change in personal work practices towards empowerment, lateral organisation, etc. Therefore a ‘pushy’ implementation does not help much, rather management changing their work, e.g. be only reachable through RTC, is a better driver.” Although written guidelines might not be a push factor in itself, one expert remarks that the process of engaging with RTC while writing such guidelines is an informative learning process that could foster the application of RTC.

To sum up, two main conclusions may be drawn from the findings presented above. First, RTC enables and strongly values synchronous communication which may, on the one hand, overcome some of the limitations of groupware technology, on the other hand, it may even increase the communicative volume and coordination effort. Second, the effects of RTC in organisational settings are not purely determined by the technology, rather the socio-organisational environment within which RTC is embedded needs to be taken into account as well. Consequently, social protocols are needed to underpin RTC mediated forms of social interaction.

As the experts’ feedback emphasised the need to reflect specific contingencies of the RTC use, we will focus in the next section on virtual organi-
isational settings and have selected three case vignettes to describe different forms of RTC-in-use, which illustrate profoundly different outcomes of the introduction of RTC.

3. Real-time communication and the dilemma of virtual organisations

Granovetter [34] has reminded us to the fact that collaborative arrangements among companies have a long tradition. The level of distributed work in a variety of forms and shapes is increasing rapidly in response to fierce competition, fast-moving global markets and the proliferation of ICT. Innovation and productivity in many industries depend on the ability to manage distributed operations, specifically distributed teams. Virtual organisations have been heralded as a logical answer to today’s challenges [35].

On the surface, the development of RTC fits well and indeed endorses the development of virtual organisations: ever more advanced ICT enables distributed, efficient, fluid and smart organisational structures. But is it then also subject to the critique that the optimistic claims about VO usually ignore the underpinnings and preconditions of productive collaboration: trust or social capital and shared understanding [35]?

The concept of the virtual organisations is often portrayed as “all star teams” [36], i.e. a collaboration of experts, who only spent part of their time on the joint project, and whose efficiency crucially relies on the ability and willingness to share or pool their expertise and to coordinate their efforts. However, this optimistic view of virtual organisations typically ignores that collaborative arrangements typically are precarious, underorganised (formally and informally) and difficult to manage [37].

Ability and willingness to collaborate cannot be taken as given; experts in their respective fields are not necessary talented team players. Moreover, the very characteristics of “virtuality” – namely computer-mediated communication, fluidity, limited time frame, changing teams – undermine the development of trust, investments in social capital as well as the development and maintenance of a shared context of experience and understanding [38].
Stylized characteristics of virtual organisations

- Task structure: ill-structured, knowledge intensive
- Organisational setting: flexible, fluid
- Mode of communication: computer-mediated
- Competence profile: all star

Voids in the concept

- Stabilizing mechanisms
- Joint experience
- Shared routines
- Ability and willingness to share knowledge
- Incentives and non-contractible issues

Table 3: Inconsistencies in VOs

Introna [35] suggests a possible response to this dilemma in defining quite narrowly the “space of possibilities for the virtual organisation”, i.e. if a setting is chosen whereby the relevant competencies are explicit and the level of integration is low, virtual arrangements might work.

Another option, which we would like to explore further, is to reflect on ways of filling some of the voids highlighted in Table 3. If an environment can be created which facilitates joint sense making, sharing of experience and developing routines of collaboration and exchange, the benefits of virtual organisations might be brought to fruition. Malhotra et al. [2] report about distributed innovation at Boeing-Rocketdyne and reflect about the organisational and institutional arrangements within which technology was successfully embedded, appropriated and used.

The experts in the Delphi study have emphasised the potential benefits of RTC in distributed settings as it provides at the same time a rich and flexible set of communication services. In particular the seamless integration of voice and video communication combined with an availability status might help to create the development of social capital, which facilitates collaboration. But these are only technological affordance, which need to be exploited or mobilised in specific organisational settings.

3.1 Case vignettes about the use of RTC in virtual organisations

We have selected three case vignettes to illustrate different forms of virtual organising, different modes of RTC use and different outcomes.
3.1.1 Case 1: Distributed research teams at two universities

RTC has been introduced to provide a richer and more immediate communication environment for two research teams, which are located at different universities (A and B) in two European countries and are both members of a large EU project consortium. The project manager (P), who is also PhD thesis supervisor to a number of team members, had recently moved from university A to university B and personally visits university A about 4-6 times per year.

In terms of virtual organizing, the members of the two research teams are involved in multiple research projects in different constellations: some of the projects are joint projects between universities A and B, some take place only in one location. Membership in the different project group varies.

After P had left university A the morale in the research group had deteriorated, even though a regular flow of email exchanges and occasional phone conversations was maintained. The atmosphere changed dramatically after RTC was introduced in both research teams. The visibility and approachability of the research manager increased and little routines about signalling and interaction were developed. Instant messages, instant message conferences, phone and conference calls were initiated spontaneously whenever needed. Even though the already high volume of communication events increased further, which added to the fragmentation of P’s daily routines, the perception of connectedness, the improved morale and productivity of the teamwork as well as the ability to quickly address and solve issues more then compensated the negative impact. The frequent verbal exchanges facilitated a regular sharing and “synchronizing” of contextual information, which had not happened in the email exchanges, kept P and the team members in the loop. (for a related analysis see: [39].

The extended sharing of contextual information supported the maintenance and extension of joint understanding and interpretation of the situation. It provided a rich environment for productive collaboration even where tacit knowledge was involved and knowledge integration was needed. The form of virtual presence facilitated what development psychologist call secure attachment [40]. RTC provided a communication channel to signal availability and allowed the team members to explore and look for solutions themselves, while being able to search assistance when needed. Being able to respond quickly and provide support when needed allowed the project manager to usually remain in the background and still create a sense of security among the team members and bolstered the confidence of the team members.
3.1.2 Case 2: Distributed Web solution development team

As part of an Internet start-up operation (I), a distributed multi-disciplinary development team has been established. In addition to a core team employed by I, a small network of collaborating companies with dedicated team members was set-up.

The goal of the first phase of the virtual organisation was to develop a Web based solution within a year until the going life. After the initial phase, development activities continue to add more functionality and the life system needs to be maintained.

RTC was used to establish regular communication among the dispersed team members, to post problems or open issues. As a result an environment emerged which enabled and facilitated frequent and productive exchanges among the various experts. This led not only to the emergence of a shared understanding of the joint task, but also to the development of a team spirit across organisational boundaries. In addition to RTC, Wikis were used as flexible and collaborative form of documentation and indeed reification of the joint work.

Reflecting the specific development task, RTC has been complemented with a form of documentation which allows for (and records) comments, contributions or changes. So the fluid and migratory forms of communication were complemented by more tangible forms of documentation which reflected the specific task structure of distributed development. Combined, communication and documentation, facilitated a fast and intense learning process. Intense work at the joint task – even at odd hours – embedded in a dense communicative environment facilitated the emergence of social capital and team spirit across organisational boundaries and the development of a project team identity.

3.1.3 Case 3: International consultancy operation

In an international consultancy operation, RTC is used to provide communication links between the central office in the US and consultants primarily working in developing countries. Initially, RTC was seen as a significant enabler of the dispersed operation. Virtual presence allowed for efficient synchronous communication across long distances and different time zones. Team leaders could “see” whether there team members were online and communicate with them on a more regular basis.

What used to be “Cowboys”, largely unconnected, decentrally operating individuals and small teams turned not only into “Cyber-cowboys”, which were now connected amongst each other and to the central office [41].
However, the connectedness changed the decision structure: whereby in the past decentralized decisions were inevitably prevalent, the introduction of RTC lead to an increasing uncertainty about the level of decentral decision power. It increased the perception of centralized control and power.

The evidence suggests that the management style and culture have a strong influence on the impact of the communication and decision routines.

3.2 Discussion

If we revisit Introna’s argument in light of the sketched anecdotal evidence, we argue that RTC-in-use can help to extend the space of possibilities for the virtual organisation into a realm of tacit competencies and integrated or interdependent competencies. As the notion of RTC-in-use already signals, we are not suggesting that technology will determine the effects. And yet we have seen certain configurations of underlying values, team size and structure, tasks structure, complementary technology, incentives to share and a culture of experimentation and reflection [35], in which RTC has facilitated virtual forms of organising. On the other hand, RTC was perceived as rather detrimental in case 3.

![Fig. 1 The space of possibilities for the virtual organisation (adapted from Introna 2001)]
Conclusions

RTC has been developed and introduced into the market as a new genre of communication services. It targets in particular virtual organisational arrangements. A Delphi study has been conducted in order to critically examine espoused effects and to explore the affordances of this new genre and to position it vis-à-vis earlier forms of communication and groupware service.

While the technological affordances seem to fit the needs of virtual organisations, the outcome, potential side effects and contingencies remained unclear. Hence, we extended the research design in order to capture ways, in which the technology is actually used, how the forms of usage are introduced, negotiated and developed over time.

A first set of case vignettes illustrate the linkages between organisational settings and challenges and the embedding of RTC. Different, still tentative interpretations have been offered to make sense of the outcomes. They reach out to different disciplines and patterns of interpretation, which suggests that sense-making about RTC should primarily happen within a rich organisational setting. Even the notion of virtual organisation may be misleading as it suggests a greater level of common practices and similarities than actually may be the case.

Future work needs to focus more systematically on longitudinal, ethnographic field studies to develop a more grounded and differentiated understanding. Specific areas of scrutiny should include:

- managerial structures, including decision structures and power distribution;
- organisational culture and organisational practices of communication, collaboration and knowledge sharing;
- relationships among the communication partners;
- transformation of communication patterns and practices.

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The E-sessions on Friday morning featured three presentations on various types of networks: manufacturing, emergency relief, and public transportation and retail services. Recurrent themes included network coordination, network failures and learning, internationalization of networks and network concepts, and the various roles of customers in networks.

The first presentation of the paper entitled *Coordinating and Boundary Spanning Roles of Business Networks* communicated results from three case studies on manufacturing and technology networks. The paper analyzed across the cases the role of ICT support and boundary spanning roles. Boundary spanning could refer to the generic roles of innovator, project leader, sponsor, gatekeeper and implementer. Lessons of failure were shared. These were caused by cultural diversity, intra-organizational miscommunications, and disagreement about the sharing of financial resources and risks, to name a few. The discussion at the conference of the paper explored how networks could handle international diversity of network participants, and how network size impacts coordination efforts, and formality and simplicity of coordination mechanisms. As networks become larger, participants run the risk of exploding coordination needs. This could be addressed by formalizing simplifying and interorganizational coordination.

The second paper – *Inter-organizational Network Coordination: The SARS Case* – explored network formation and coordination following the SARS outbreak in 2002. The World Health Organization (WHO) formed multiple networks to address urgent challenges in the areas of operations, expertise-development, and governance. Conceptually, the paper focused on the incident-driven nature of these networks (Denning 2006), and the relationship between network capability and actual performance (Hagel et al. 2005). The subsequent conference discussion zoomed in on the ad hoc nature of these networks (Vervest 1994), and the role of information technology and operating rules. Furthermore, the complexity of understanding – under time pressure and at various levels of the network – the true nature of an emergency situation was explored. Achieving such understanding is difficult yet essential for devising and executing well-coordinated action patterns. Recent examples in the private (Enron, Ahold) and public sector (Katrina, Tsunami) underscore this challenge and need for improvement and further research.
Finally, the paper Customer-Centric Business Networks: The Case of the Evolutionary Network of Octopus tracks the evolution of a highly successful electronic payment system in Hong Kong. Starting out as a small network in 1994 to facilitate payment for public transportation, the Octopus network gradually included numerous organizations delivering services for various retail transactions. The conceptual model proposes that a network’s relationship with customers evolves across four levels of adding value: commodities, branded offerings, loyalty, and solutions. The presentation and subsequent discussion centered on the expansion of Octopus to The Netherlands. This concerns the introduction of a single public transportation card in The Netherlands called the OV Chipkaart (http://www.ov-chipkaart.nl). Lessons learned in the Dutch project at this stage suggest that successful replication of a network concept from one context to another can be difficult due to differences in financial, legal, and societal aspects of local societies. Knowledge that is unique to a particular context must thus be taken into account (Tyre et al. 1997; von Hippel 1998).

Reflecting on the three presentations and discussions, fascinating and important research themes emerged. How do boundary spanners bridge intra- and interorganizational processes in networks? Individuals in this role must deal with conflicts that are normal since networks involve organizations with often only partially overlapping interests. How do ad hoc networks tap into organizational resources and leverage these? Public and private organizations should build collective capabilities so that when disasters strikes or opportunities arise, they can quickly connect and deliver timely services (Vervest et al. 2000). How do networks such as Octopus from Hong Kong evolve over time and maintain momentum? And finally, under what conditions can network concepts be replicated internationally and take local idiosyncrasies into account, see also (Kogut et al. 1992; Winter et al. 2001)? In an increasingly global and fast-moving world, these questions will engage academics and practitioners alike.

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28. Supply Network Game Based On Cordys BCP

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Abstract

MIT Beer Game is a typical lab experiment for the education of supply chain. For easy operating manually, the game is simplified with some assumptions and conditions. Now more and more people play the game with support from computers and even did it on-line. In this paper, a supply net game based on Cordys BCP was introduced. Besides the basic functions of electronic beer game, a multiple-supply-chain-network was introduced into the game to simulate a competitive environment. More factors, such as total number of players, the number of players for each role, delay, transparency of information, etc, can be set flexibly by game controller and players. Thus, more realistic supply network can be created and studied. Each decision and sequential results can be recorded in database and demonstrated after the game. This game can also play as a platform to carry on research on smart business network.

Keywords: supply network, Beer Game, SBN

1. Introduction

MIT’s Beer Game is one of the most famous experiments in supply chain management. It illustrates the bullwhip effect perfectly. In the last century reasons for bullwhip effect in supply chain system were widely studied, and the MIT’s Beer Game remains important. The original Beer Game should be played on a plat board. After its great academic success many computer assisted Beer Game platforms were developed. Automated calculations and data analysis functions were integrated in these platforms, which make players concentrate more in their decisions.

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22 Research project is supported by Cordys B.V.
A New Supply Network Game will be introduced in this paper. The idea comes from MIT’s Beer Game. Competition is a key characteristic in supply chain environment, so this Supply Network Game is designed to illustrate the competitive environment. An IT platform based on CORDYS BCP will be designed and developed simultaneously to facilitate the decision process during the game.

In chapter 0 MIT’s beer game and two platforms will be introduced briefly. In chapter 0 the current version of Supply Network Game will be described. In chapter 0 future work will be scheduled, thus the blueprint will be clear.

2. CLASSIC BEER GAME AND ONLINE GAMES EXISTING

In this chapter MIT’s Beer Game, one of the most famous experiments in supply chain management is reviewed briefly. The functionality of two available online game platforms will be analyzed in section 0.

2.1 MIT’s Beer Game

MIT’s Beer Game is possibly one of the most widely used classroom exercises for demonstrating the dynamics of a supply chain. The System Dynamics Group developed the exercise at the Massachusetts Institute of Technology's Sloan School of Management. Appendix 13A in [1] explains the rule of MIT’s Beer Game in details and Chapter 13 in [1] analyzes the reasons for bullwhip effect. The structure of beer supply chain in the game is described in the following chart.
2.2 Online games existing

Two platforms are available on internet and can be accessed for free. One is “the MIT Beer Game” developed by The MIT Forum for Supply Chain Innovation, and the other is “Beer Game” developed by MASYSTEM website. These two platforms were designed and developed to support MIT’s Beer Game. Their functionality is similar. The functional differences are detailed in the Table 4.

<table>
<thead>
<tr>
<th></th>
<th>The MIT Beer Game</th>
<th>Beer Game by (Ma system)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Monitor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last week back order</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>This week satisfied</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>demand</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parameter Configuration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Configure computer</td>
<td>Several Choices</td>
<td>Two Choices</td>
</tr>
<tr>
<td>inventory policy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Configure customer</td>
<td>Only for administra-</td>
<td>Unknown</td>
</tr>
<tr>
<td>demand</td>
<td>tor</td>
<td></td>
</tr>
</tbody>
</table>
### Table 4 Different functions between two platforms

<table>
<thead>
<tr>
<th></th>
<th>Two Choices</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay configuration</td>
<td>Two Choices</td>
<td>No</td>
</tr>
<tr>
<td>Information mode</td>
<td>Sharing mode/Separate mode</td>
<td>Only one</td>
</tr>
<tr>
<td>Report</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Graph Analysis</td>
<td>All four graphs</td>
<td>Only Order-Week graph</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Flexible</td>
<td>Fixed</td>
</tr>
</tbody>
</table>

The differences are grouped into five aspects, i.e. monitor, parameter configuration, report, graph analysis, and flexibility. There are a few functions under each of them.

### 3. THE GAME OF SUPPLY NETWORK

Supply Network Game bases on MIT’s Beer Game. The same scenario, products distribution scenario, is used in Supply Network Game. S. Chopra and P. Meindl pointed out the policies in supply chain management could be divided into three classes: Strategy policies, tactical policies and operational policies.[1] In Supply Network Game players will concentrate in tactical policies, such as inventory policies, but cooperate in a competitive environment. In section 0 the main frame of the current version is described, and in section 0, 0 some important modifications are explained in details.

#### 3.1 The Main Frame

The competition in Supply Network Game is based on a multiple supply chains structure compared with the single supply chain in MIT’s Beer Game. However, only one modification on network structure is not enough to demonstrate the competition. So the competition enhancement is needed.
where some products distribution elements existing in MIT’s Beer Game are modified.

![Figure 17 Main frame of Supply Network Game](image)

### 3.2 Supply Network Structure

Supply network structure is an essential modification, where a dynamic supply network is built and functions during the game. In original single supply chain structure there is only one player for each role, which is to say one factory, one distributor, one wholesaler and one retailer. But in a supply network there can be multiple players having the same role. In the beginning of the game all players function as one entity to achieve the distribution task. Obviously there is competition between the players with the same role which can be identified as internal competition mainly. After several rounds some supply chains may come into being, so the competition consists of internal and external competition at that time. An example is given in the following figure, where blue arrows represent order flows and green arrows represent material flows:

The word ‘dynamic’ is used in the former description, because to make the game more flexible the network structure should not be implemented in the code. The administrator of the game has the right to modify the network structure according to the player number and players’ requirements. In addition, during the game the administrator can also add or eliminate a player in order to simulate the bankruptcy or the new company entry events. The ‘dynamic’ requirement can be modelled as the problem to save the structured information into the two dimensional tables in database where multiple IT solutions are available at present.
3.3 Competition Enhancement

With the supply network structure the competition can be felt by players. Now the feelings should be connected to the evaluation system. In MIT’s Beer Game final scores are measured according to the cost, which is calculated each round by inventory level and back orders. One unit back order results in two units cost for the upstream player. So players pay more attention to order quantity than to selection of upstream players. This will not help to form solid products distribution structure, which is always regarded as the prize for winning the competition. To avoid this phenomenon we modified relationship between back order and cost. After the modification one unit back order results in two units cost for the upstream player, and also results in one units cost for downstream player. This direct cost surly makes players pay more attention to their decisions in both quantity and selection of upstream players, and sharpens the internal competition indirectly.

In MIT’s Beer Game product distribution behaviour aims to minimize the total cost. After integrating the supply network structure, this policy lets the player who keeps a zero inventory and sells nothing win the game. So in this game selling behaviour should make profits. In the end of the game the richest player, that is the player have the biggest profit, wins the game. Profiting system has been designed but has not been implemented in the current version yet.

4. IMPLEMENTATION ON CORDYS BCP

Supply Network Game is implemented on Cordys BCP (Business Collaboration Platform), which is an application service solution for enter-
prise, developed by Cordys Systems B.V. in Netherland. The core techniques of Cordys BCP are XML, web services and process management.[3]

Supply Network Game is developed with BS architecture which is illustrated in Figure 19. HTML pages with Java script are used to transfer messages between browsers and server. SOAP methods are used to read from and write to backend with the help of Cordys integrator, which is an essential component in Cordys BCP. Using Cordys BCP simplifies the communication with the database, and helps to keep the HTML pages in similar patterns.

![Architecture schema of Supply Network Game](image)

**Figure 19  Architecture schema of Supply Network Game**

**5. FUTURE WORK**

Supply Network Game is designed to illustrate the competition. To strengthen the competition and to construct a fair play environment in game are primary missions. Many business characters can be added to system and many algorithms can be redesigned to make them more logical. The following two points are being studied and designed but anyway they are not the only models needed by system.

In current version only downstream players can decide their suppliers and orders’ quantity but upstream players can only accept the orders. Upstream players sometimes have to afford extra cost by downstream players’ reasonless decisions and are always disposed at a passive place. To
make fair play environment a negotiation system will be designed and implemented in the next version of Supply Network Game, with which upstream players can decide how they make their own business.

Business events are to make profits. Now players’ performances are measured only by cost, which makes doing nothing the optimal choice. So an effective evaluation system should be designed and implemented in the future. The ideal evaluation system should include a financial system and a market analysis system which are being designed at present. With the financial and market data players’ performances can be measured in multiple scales. These facts, obviously, will encourage players to make business and to try their best to discover their optimal decisions.

6. CONCLUSION

The idea of this research comes from MIT’s Beer Game. The purpose is not to make the game complicated but to illustrate another important characteristic – competition – in supply chain management. In order to introduce competition into Supply Network Game, the supply network structure is restructured and the back order cost policy is reset. An IT platform is therefore a necessary part of this research because there are too many calculations involved in each round of game and some logics of the calculations are not easy to be carried on. It is believed that more work in the future is needed to make the Supply Network Game and its IT platform more perfect.

References
29. Smart Business Networks: Core Concepts and Characteristics

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Abstract

The paradigm of Smart Business Networks (SBNs) handles and thrives in highly dynamic and rapidly changing markets or environments. SBNs can be powerful forces when implemented correctly, yet current literature primarily consists of case studies and ad hoc observations, lacking formal description. This paper provides the beginning of such formalism, discussing the key strategic aspects in their construction and maintenance. SBNs are dynamic by design and by necessity; this paper provides central ideas derived from a combination of published literature, general observations and class discussion, rather than a step-by-step approach to their construction and maintenance.

Keywords: Frameworks, Design, Formalisms, Networks

1. Introduction

Smart Business Networks are a modern organizational form that is currently emerging rapidly. The ubiquitous use and availability of information technology is the driving factor behind its emergence in the beginning of the 21st century. SBNs are a new form of competition emerging due to changes in the marketplace.

Historically, as the marketplace changes, some companies adapt to new ways of doing business, some fail, and a few lead the pack; they develop new methodologies and strategies based on emerging technologies. These strategies often change the organizational structure, speed and size of
competitors and effective competitive units. Some of these changes seem to be cyclic. For example, the integration into larger conglomerates followed by a disaggregation into smaller more independent units. These are sometimes referred to as centralized and decentralized organizations. Each cycle introduces new relationships and connections that are embedded in either extreme form of organization.

We see examples of this by looking back at the local independent general stores popular at the turn of the 19th century. Most of the early 20th century was about an increasing trend of consolidation leading first to department stores, and then eventually to “killer category stores.” In the latter part of the 20th century, information technology emerged as a critical business instrument. Stores like Amazon.com and markets like eBay have carried the killer category store into the virtual world of e-commerce and have competed with the physical killer category store, often more effectively. Crossing into the 21st century, we see that businesses are now integrating the physical with the virtual environments. Items that traditionally required a trip to the store or factory are now purchased online, e.g., cars, clothing and jewelry.

Contrary to the expectations of the “dot com” boom, this is not a new, separate economy. It is rather a digitally enhanced and transformed economy. This digitally enhanced economy integrates what was called the “new economy” with the traditional “bricks and mortar” economy. The cycle of consolidation and disaggregation continues, but is now information-based and network-enabled. In this emerging competitive environment, business strategists are seeking the combined benefits of centralized and decentralized organizational structures. Information technology is used to enhance individual businesses, open virtual markets and join global e-commerce enabled markets. Networking technologies are also enabling an emerging integration into Smart Business Networks (SBNs) with centralized goals and objectives. These SBNs are typically collaborative networks of competitors operating across physical distances and using virtual integration techniques.

Consolidation continues as individual and small collections of businesses join into larger (sometimes multi-national) corporations. These larger collections of firms are striving to organize and control the entire product life cycle: from concept formation, material acquisition, processing, to fabrication, assembly or construction, and sometimes even including maintenance and disposal. This virtual consolidation trend can be used to increase market penetration in areas that were previously cost prohibi-
In addition, collections of firms are more readily able to diversify and customize their offerings to specialized and/or unique markets. Sony is an example of a large multinational that produces consumer electronics, music, movies and a host of other entertainment related services [16].

While diversification does insulate from the dependence on individual marketplace swings, amassing so many functions, responsibilities and dependencies makes it difficult for the monolithic organization to adapt to rapidly changing markets. Many large businesses therefore choose to split the organization into several (semi-)autonomous entities, which can be more agile and able to adapt rapidly. IBM, Alcoa and CitiBank are just a few of the well-documented cases of this phenomenon. Over time and as market conditions change, these entities often maintain synergy via network topologies enabling agile integration of capabilities needed to meet evolving market demands.

1.1 The Emergence of SBN Infrastructure

The development of the Internet from an academic tool into a mainstream communications network started another shift in the way the world does business. The Internet provides a medium to ubiquitously transmit substantial amounts of information across any physical distance almost instantaneously and at minimal cost. As the cost of communication drops and its complexity increases, the required infrastructure for networks of entities doing business emerges. The major barriers in distance communication are now syntactic and semantic – cultures, languages, data formats and their interpretations – as the transportation mechanism is now almost instantaneous, almost cost-free, and highly secure. These characteristics promote the development of a new style of doing business. Moving across fluid states, this style begins with loosely-coupled task-grounded Virtual Organizations, to the longer-term and trust-worthy Collaborative Networks, culminating at the ground-breaking Innovation Networks [7]. The Smart Business Network paradigm provides the mechanics and characteristics necessary to make these transitions in highly dynamic marketplaces.

1.2 A Network Phenomenon Example

In studying trends over the last century, one sees the development and emergence of the Smart Business Network [10] in the conglomeration-fragmentation cycles. The importance of relationships between nodes in a network, relationships between networks, and the recursive embeddedness
of a network as a node in another network are all critical success factors in SBNs.

SBNs leverage a network of relationships to add value to their product(s) and enable collections of smaller organizations to compete for business with larger ones – a feat that can be highly unsuccessful if attempted by small organizations acting alone. This particular network effect – the power of many over one or a few – is sometimes called the swarm effect.

The power of the swarm effect is exemplified in the credit card market. Historically, as credit cards became more prevalent in society, some companies gained a wide market share early (e.g., American Express (AMEX) and Diner's Club). These larger players helped to establish the credit card market itself, but also made it difficult for smaller players (e.g., local banks, family-owned stores, and other businesses) to compete. Smaller players were providing their own credit cards, yet these were usable only within a subset of the commercial landscape (often only within that specific area of the bank, store or organization). However, once these small entities could join a network (such as VISA or MasterCard), many chose to do so. This resulted in powerful networks, as any member entity's card was then usable across all vendor organizations of the network. These networks are now perceived to be equal (if not superior) contenders in the credit card market due to the breadth, power, and identity attributed by (and available to) their membership. These perceived benefits are noticeable even to larger players, as recently Diner's Club joined the MasterCard network.

SBNs are successful due to the characteristics and latent abilities that arise from a loosely-coupled, fluid and efficient network system. This paper strives to describe the major ideas in understanding such fluid and agile organizations including relevant definitions, theoretical concepts and recognizable characteristics.

Section 2 will discuss core theoretical concepts in the SBN paradigm. These concepts outline the major ideas that should be understood and applied throughout the SBN lifecycle. Section 3 discusses high-level strategic characteristics of such networks. These characteristics are the result of effectively applying the concepts outlined in Section 2, and can be used to judge the "healthiness" (in terms of growth-capacity, sustainability, general effectiveness, etc.) of SBNs. Section 4 applies these concepts and characteristics to an example SBN currently under development by U.S. Customs. Conclusions are presented in section 5.
2. Core Concepts

The core framework of the Smart Business Network paradigm involves four concepts: (1) Information Integration, (2) Trust in relationships between nodes, (3) Network-Node Duality and (4) Overlapping Parallel Interconnected Networks. These high-level design concepts, when integrated appropriately, provide the framework for a mechanism that can react quickly to its environment, self-optimize through reconfiguration, and utilize nearby resources when needed – to sustain itself in a highly dynamic environment.

2.1 Information Integration

Information integration is perhaps the most often described benefit of business networks. Information integration enables the other three core concepts outlined above. “Integration” refers to many aspects of information in a system: technical (data formats and tools), logistical (efficient and appropriate transmission), and strategic (application and value). Integration is performed across these aspects and at different levels, with the “deeper” levels providing greater value and power, but also requiring greater trust and (generally) longer-term relationships.

Six levels of information integration are proposed, in [7], beginning with access, or the simple “ability to look-up or request information in one or more ‘sessions’ ” as the first level of depth. Amazon.com reinvented the book business using access to provide convenience. Having access to information then leads to promoting transaction of goods, services or money, as exemplified by the benefits to each of the suppliers in Dell or Cisco’s supplier networks from integrated transactions. The next level is digitizing the information, relying on digital information technology to replace or enhance physical processes and systems. As an example, the gambling slot machine business was reinvented by digitizing the handling of coins, and using customer relationship management (CRM) as well as data mining techniques to maximize profits and customer satisfaction.

Digital information enables the next three levels: forming Virtual Organizations, then Collaboration Networks, and finally Innovation Networks. While the first three levels enabled innovative actions and interactions, the focus is on enhanced goods, services, solutions and experience – the things SBNs provide to their clients. The next three levels focus on enabling cooperation inside the SBN and with its suppliers and customers. Here, the focus is on enhancing cooperation through various levels of ef-
fectiveness from simple cooperation with others in a Virtual Organization to collaborating and innovating in what is now called an open innovation environment. These last three levels deal with the ability of nodes to collaborate on everything from products and services, to innovation. A good example for Virtual Organizations are the airline alliances: OneWorld, Star Alliance and Sky Team. Reaching the deeper levels of information integration requires higher trust (further discussed in Section 2.2) and standards across the communicating nodes, but provides very powerful value in terms of convenience, transparency, interactive facilitation, charisma, and the ability to successfully make rapid dramatic changes to an organization. Collaboration Networks such as VISA and MasterCard are examples of this level. At the final level, Innovation Networks are emerging and evolving to meet changing business needs. Xerox formed an Innovation Network when it recognized a shift of its market from a “print then distribute” to a “distribute then print” methodology [7]. The innovations required to compete in this changed marketplace required Xerox to innovate together with other companies in creating new solutions for the “distribute and then print market.” Xerox therefore invited Adobe, Kinko’s, AT&T, IBM, and Apple to brainstorm solutions on handling the change. Xerox became a node in a business network (see Section 2.3) and the companies grew stronger, despite the fundamental market changes. Similar innovations are clearly needed in the music, video and entertainment industries as they transition to distributing their products and services in digital form. Innovation networks in this domain are developing at the time of this writing.

The six levels of information integration proposed in [7] can be mapped to the technologies in the Semantic Web “layer cake” created by Tim Berners-Lee, the inventor of the World Wide Web [1]. This layer model envisions the extensible Markup Language (XML) at its base. Today, XML is seen as a fundamental common data exchange format. XML is the main technology enabling access, transaction and digitization. The next layer is RDF (Resource Description Framework), which is the first building block of the Semantic Web. The second building block is OWL (Web Ontology Language), which is based on RDF. These two Semantic Web technologies are needed to enable Virtual Organizations and Collaboration Networks, as they allow easy, automatic and fast interoperability between many different systems. These capabilities are crucial for networks in which the members can change rapidly. Based on these Semantic Web technologies are the notions of logic and trust. Logic, in this context, generally refers to mathematical logic, and in most cases first-order logic. Logic provides greater expressivity than could be achieved with RDF or
OWL. Trust here refers to trust between nodes in the network (and is further discussed in Section 2.2). Logic and trust, in the context of Collaboration Networks, provide the necessary foundation for Innovation Networks. Please note that the technologies outlined in the Semantic Web “layer cake” are not the only ones that enable these six levels of Information Integration, but they are generally recognized standards that businesses can use to achieve a particular level.

2.2 Trust in Relationships Between Nodes

Trust in relationships between nodes is a critical core concept of SBNs. Nodes must be able to rely on each other. As relationships differ for different networks, this reliance may be defined as providing goods and services or to keeping their promises. Regardless of the realized definition, it always derives from the commitment to the success of each and every node in the network [5][7][8].

Early virtual networks failed because each node was committed to its own success (and perhaps that of the client), but not to the success of all its partners. The reader may recall the lifecycle of the PowerPC chipset: first the result of a partnership in 1991 between Apple, IBM and Motorola (a.k.a. the “AIM alliance”) to provide a chipset and operating system (called “PowerOpen”) to support both IBM and Apple systems [12]. In 2006, the PowerPC chipset (being primarily used in Macintosh systems through this time) is being replaced by an Intel design, PowerOpen never came to fruition, Motorola spun off their chip manufacturing processes (into the company Freescale Semiconductor), and IBM has sold off its line of PC products, with recent design of the PowerPC platform geared towards next-generation gaming consoles (e.g., Nintendo Revolution, Sony Playstation 3, Xbox 360) [15]. While there may have been a multitude of reasons for this outcome, it may be argued that had these companies invested more effort and trust into the success of each other and the project (rather than focusing on their own), they may have provided a platform that would today be a serious contender with the Operating System and PC hardware markets.

Once nodes reach a sufficient level of trust in their relationships, they can attain opportunities that were previously unavailable when acting alone. Trust in relationships is a core enabler of SBNs’ latent capabilities. As a node becomes more integrated into a trusted network, it can offload more and more of its extraneous (non-core) duties to that network. This allows the node to focus on its core competency. This focus, in turn, makes the node more valuable to the network as it has a specialty that it
can refine and enhance, and upon which other members can use and rely. Bear in mind examples such as the aforementioned Xerox network, the Dell supplier network or that of Cisco. Each are comprised of sub-networks and organizations that specialize in some aspect of the overall operation (e.g., customer service, logistics, research and development), yet confidently rely on and trust their network partners to provide other necessary functions (such as product development, revenue generation, healthcare acquisition, technological maintenance) for the successful operation of their sub-network, and the greater network as a whole.

A powerful SBN can therefore be recognized (in one form) as a network of highly-specialized nodes, which use trust-based relationships and information-based technologies (as appropriate) to build dynamic collections of capabilities, to meet evolving requirements and to develop innovative solutions. In this form, the network demonstrates value for all nodes, providing an incentive for previously independent nodes to join or remain in the network and use it to fulfill their individual needs. Plus, with this heightened level of trust, member nodes can focus their full energies on their duties and competencies, without spending substantial resources on backup plans, double-checking contracts, or other precautions often necessary to protect oneself in trust-less relationships.

A powerful SBN reveals (in another form) nodes using the network for leverage while competing in their individual markets. The SBN provides a potent capability at the network level to all member nodes: trust enables the success, but there is no strong mutual dependence, as in supplier networks. Examples of this are found in the VISA and MasterCard networks. Within them, a few strong, shared nodes administer the various components of a credit card system, while individual card-issuing nodes use the trust factor to enable the swarm network effect (discussed in Section 1.2).

Trust is a multifaceted concept. When asked to define trust in a network relationship, many versions of definitions and expectations are found [9]. The creation of an ethical agreement, spelling out explicitly or generically the expectations of the network in the relationships between its members, is a powerful and (quasi-)formal trust-building tool. Refer to the ethical agreement in [4] used initially by the Agile Web as an example.

Trust takes time to establish, but can be expedited by facilitators experienced in trust-building. Trust can, by its inherent nature, be transitively enhanced as well. For example: if A trusts B and B trusts C, then it is likely that A will more quickly and easily trust C.
Defining trust as a core component of an SBN results in major part from analyzing the failure of various Virtual Organizations where trust in the relationships between nodes was either ignored or not sufficiently emphasized. In analyzing Virtual Organizations we do not always find failure due to a lack of trust; sometimes the lack of trust simply limits or inhibits additional growth or capability. For example, most of the airline virtual organizations are not based on significant trust between the nodes. In the Sky Team alliance, Continental and Northwest upgrade their elite members for free, while other members do not. When asked about upgrades, Delta (a member of the Sky Team alliance) suggested they upgrade their own frequent flyers but not those of Continental. While we have highlighted this example, the reader can decide whether or not this is an example of insufficient trust limiting the perceived value of the alliance.

2.3 Network-Node Duality

The ability for a node in a network to be a network itself is another core component of SBN phenomena. Network-Node Duality suggests that networks are comprised of interconnected nodes, and that a network can simultaneously be a node in a larger network. This kind of duality is demonstrated in Figure 1, where the Cisco network is both comprised of nodes while it can also be a node in a larger communications network.

Note that according to this duality as currently defined, the terms “network” and “node” are interchangeable. For clarification therefore, this paper will furthermore use the term “network” to refer to network-oriented aspects (e.g., component members, intra-communication, organization), and the term “node” in reference to nodal-oriented aspects (e.g., characteristics, inter-communication, qualities, responsibilities).

A node in an SBN is often an autonomous entity (e.g., an individual agent, department, firm) that can communicate with other entities. SBNs consist of a group of interconnected nodes that form a network [10]. These nodes can be different companies or different sections of the same companies. These nodes share information with each other to increase the value of the network as a whole [10].

Figure 1 displays the network of suppliers established by Cisco. Each node in that network is part of the Cisco SBN and finds value in being part of the network. The value is found in the ability to share information, trusting other members, and to take advantage of the synergy of the SBN. All of these factors are examples of the network effect called network cha-
Simply defined, network charisma is the benefits the network provides to a member node.

Figure 1: The recursive nature of networks and nodes. Slightly modified from [3].

Also shown in Figure 1, the Cisco supplier network can be viewed as a single node in a larger network, and has nodal charisma itself. In a similar fashion, the Dell supplier network is a node from which people and companies purchase computers. The brand name associated with “Dell” or “Cisco” is another example of node charisma.

The recursive embedding of networks in nodes and the hierarchical nature of such embeddings allows for abstraction and focus in the study and analysis of SBNs, from both practical and theoretical points of view. Referring again to Figure 1, an organization forming a network of suppliers to provide computer networking solutions might choose Cisco as one of its nodes. In such an SBN, Cisco is a fundamental node and establishes relationships and business based on being a node in this new network. Still, Cisco continues to execute their commitments and support their operations by employing their own network of suppliers, and so forth. Therefore, Cisco acts as a node in some aspects and a network in others, demonstrating the concept of the network-node duality.
2.4 Overlapping Parallel Interconnected Networks

The discussion so far has implicitly suggested that one network, perhaps with recursively embedded networks and nodes are what make up an SBN. However, this is an oversimplification. Another core concept of SBN network topology is the application of overlapping parallel interconnected networks. Consider the benefit of separating the flows of money, materials, information, people, etc., in traditional supplier networks in order to optimize performance. If sufficiently separated (logically, physically, or otherwise), each of these flows represents a parallel flow within an overlapping network.

One illustration of overlapping parallel interconnected networks is found by considering the parallel networks of the human body. The circulatory, nervous, and lymphatic systems are each a network of special cells and organs working in parallel, interconnected in that they communicate and coordinate, and overlapping in that they cover similar regions of the body in different ways.

For example, each system contains a distinct non-intersecting transmission and distribution system – blood flows through veins and arteries, nervous perceptions travel across neurons, and lymphocytes travel across diffuse lymphatic tissue. If some kind of trauma happens (such as a cut on the skin), the nervous system will perceive the pain and signal the other systems to increase their production and distribution of disease-fighting cells (like antibodies through the blood and lymphocytes through the lymphatic tissue). Once the trauma is under control, signals are sent to resume standard levels of production for these cells.

SBNs use overlapping parallel interconnected networks in a similar fashion. Consider again the flows of economic resources, goods and services, and information in an SBN. Each operate across different network channels (e.g., digital, social, market), yet coordinate with each other to better succeed and survive both normal and traumatic situations. For example, if an SBN develops the information that its product or service is moving from a growth mode to steady state or even a declining market, it can avoid the traditional whipsaw effect of supply chains by using the information flow network to signal the material creation flow network of impending change. Signals across parallel networks in the same SBN are a powerful tool for achieving agility, and rapidly adapting to market conditions, stimuli (internal and external) or other changes. It is the ability of independent operation of the parallel flows that enables some synergistic
benefits, while other synergies are facilitated by the ability to communicate across networks and rapidly initiate changes, typically in response to opportunities and/or unexpected problems.

To further the profitable discussion of Smart Business Networks, we suggest a theoretical framework comprised of four core concepts: Information Integration, Trust, Network-Node Duality and Overlapping Parallel Interconnected Networks. Understanding these concepts is essential to the creation, growth, and maintenance of SBNs, and they are used to realize the strategic characteristics (discussed in Section 3) in ways that are unique to each SBN’s goals and objectives. These four core concepts, when appropriately recognized and applied, do much to enable, support and sustain the following strategic characteristics. Likewise, a lack of understanding or appropriate application for even one of these characteristics may keep an SBN from reaching its highest potential (at best), or be the linchpin leading to its downfall.

3. Strategic Characteristics of SBNs

These strategic characteristics refer to qualities or attributes of SBNs that can be more readily recognized, measured (qualitatively or quantitatively), and specifically striven for in the development and maintenance of SBNs. These characteristics are the more “concrete” results of applying the more “abstract” core design concepts (in Section 2). This section discusses two internally focused ((1) Synergy and (2) Identity) and two more externally focused ((3) Adaptation and (4) Value) characteristics of SBNs, and their respective perceived strategic value in the development, maintenance and growth of the network.

3.1 Synergy

**Synergy** is described as capabilities the network possesses, which no single member can provide by themselves. Synergy is enabled through several traits, notably a strong inter-nodal communication, an awareness of others’ needs and one’s own, and a conscious effort to meet the needs of others.

An SBN is more than multiple members working in sequence and handing off products or information from one to another to carry out the next step; this is a supply chain. SBNs operate both sequentially and in parallel as an integrated team. It requires the ability to see when another member
is overworked and sharing the load, seeing another's need and seeking to rectify it, or recognizing the potential for a novel result and combining the necessary efforts to realize it. Communication and awareness of needs, coupled with an effort to ensure that the needs of others are achieved, strengthens the overall productivity and sustainability of a network. The resulting synergistic enhancements are realized through new capabilities, opportunities, and relationships.

Capability synergy refers to those abilities realized as a result of being performed in a synergistic environment, which would not be possible otherwise. Consider, for example, the activity of building a home from raw materials: a general contractor could not feasibly do so in a timeframe that would keep him in profitable business. However, if skilled plumbers, construction workers, electricians and others are employed, this feat now becomes a realizable possibility. And, in the case of the television program “Extreme Makeover: Home Edition” [13], a network of hundreds of contractors and volunteers can reliably demolish and build a new multi-level home all within one week’s time; a feat truly out of reach of any single contractor.

Similarly, opportunity synergy is defined as those (business) opportunities possible to nodes only within synergistic environments. Considering the credit card example in Section 1.2; the VISA or MasterCard networks are only able to effectively compete for market share against large established companies (like American Express) once they had gained enough members. A second example is found when a group of small manufacturing specialty firms integrate into a network capable of developing prototype products, taking responsibility for production of complete systems or complex products, etc. For example, in the automotive world we now see collections of suppliers providing integrated sub systems. The Agile Web of PA demonstrated opportunity synergy by achieving these capabilities, and taking responsibility for their clients in developing new prototype products, providing maintenance services, and field support. When they were operating as a collection of individual companies each had one or more manufacturing capabilities, but the integrated team could take systemic responsibilities.

Relationship synergy refers to the ability to attract and retain relationships that would otherwise be out-of-reach for any single node. For a node to acquire and maintain relationships with more powerful, valued, and influential SBNs, they must have the ability to reliably provide at the speed, quality and scale demanded in the relationship. The larger entity will not
enter into a relationship that is deemed unnecessarily risky, untrustworthy, and therefore potentially dangerous or non-profitable. Since the node cannot meet these relationship needs alone, a synergistic environment is required to be able to provide the necessary support and resources. Just recently, Apple has revealed a partnership with clothing-giant Nike, and the production of a new product that utilizes strengths from each (a running shoe that interacts with the iPod nano) [14]. Such a relationship would be very difficult (if not impossible) to establish for lesser-known MP3 player manufacturers, such as Sandisk, Creative and iRiver, as they lack the charisma of Apple and their iPod, iTunes Store, and related technologies.

3.2 Identity

The identity characteristic is recognizable both at the network and nodal levels. Any node in an SBN has an individual identity while the network itself has an identity as well. Identity is an elusive, often overused word that captures the reputation, perceived reliability, ethics, values, intellectual property and the way it is handled, the customer relationship management philosophy, the relationships with suppliers, the way employees are treated and managed, fiscal policies, open or closed sharing of information, loyalty, risk taking sensitivity, handling of disputes and failures, perceptions of competitors and other players, and many other ideas and concepts of an individual node (a company) or an entire SBN. Identities are thought of as developing through inter- and intra-subjective processes and the identity of a node or SBN can be imagined as being a web of overlapping, potentially conflicting, individual identities that come to light depending on the situation [6]. Frequently, the identity of a company or SBN is referred to as the culture of an organization – an imprecise (as culture is a subset of identity) but useful analogy.

An SBN with incompatibilities amongst nodes on one or more aspects of identity has a potentially significant problem. Just as an individual node operating as a business has established its identity, an SBN establishes one as well. This occurs through explicit interactions (e.g., deliberate actions and agreements) and implicit ones (e.g., established reputations and rumors). Assuming that everything will work out on its own (implicitly) without any formal, explicit arrangements is rarely the correct approach. Rather, when forming an SBN, partners should explicitly and collectively address the most important cultural issues and codify these in an agreement, removing ambiguity on the operation of the SBN. Note that certain cultural aspects will not come to light except in special circumstances; for example, an SBN might work flawlessly until an intellectual property dis-
pute arises, revealing evidently that the members of the SBN have diametri-
cally opposed beliefs on what constitutes intellectual property and what
does not.

One subtle but noteworthy point is that SBNs may adopt and maintain
distinct identities for internal and external relationships. This is difficult to
execute, and requires careful and explicit management attention. It should
be attempted only when the node’s management perceives these external
relationships to be essential. Some cultural components cannot be handled
this way, as what a node does reflects on the network. This is the case for
the perceived reliability of the network, heavily determined by its weakest
node, and it is equally true for the way members handle customer and sup-
plier relationships. All of the external interfaces of any singular node im-
 pact and shape the externally-perceived identity of the SBN. With respect
to the internal identity components, some must be the same within the
SBN and all its member nodes to ensure appropriate operation, while other
factors can be agreed upon for the SBN with members free to do other
business differently. The degree of risk taking within the SBN might not
be the same in all individual nodes, yet the risk taking of the network
should be in agreement by SBN members for that network. On the other
hand, information sharing, access to sensitive information and information
tools for knowledge management need to be compatible across the SBN,
or else jeopardize its effectiveness.

Identity, as discussed here, is more than “branding.” Generally speak-
ing, most if not all aspects of branding are included in this definition of
identity (making branding a subset of identity, as well), identity also pre-
sents itself a characteristic of compatibility, much broader than simple
branding or even culture. The SBN’s identity should be used to determine
a sense of fit when a node has an opportunity to join an SBN, or when the
SBN chooses to invite a node to join it.

Identity and its cultural components are the basis for forming an agree-
ment on the ethical and relationship principles by which the SBN will op-
erate. While many points in this multidimensional identity space are pos-
sible, and one can imagine multiple SBNs in the same field establishing
distinct identities, it is hard to conceive of a collection of nodes success-
fully operating as an SBN with different and incompatible identities.

In summary, the lack of a shared identity is a significant difference be-
tween the Virtual Organization and Collaboration Network levels of In-
formation Integration. Branding and cultural components are included in
this definition of identity, and therefore suggest considering identity as an externally-focused characteristic. Still, the role of identity in making possible and enhancing collaboration, integration, and innovation through shared values is considered to be its major contribution, and as such is considered here to be an internal characteristic.

3.3 Adaptation

Adaptation of a SBN is defined by the ability to reorganize and refocus resources to remain competitive in a dynamic environment. A static SBN in a dynamic market will quickly lose its perceived value and effectiveness. Adaptation is an internally implemented capability in response to external stimuli. However, it is considered an external capability because its true contribution is providing (to suppliers and customers) the perception of dealing with dynamically changing requirements with great agility.

SBNs in dynamic markets must quickly and easily adapt their products and processes. Achieving this is enhanced by the use of modular strategies with well-defined interfaces. An adaptable SBN adopts highly modular strategies for its products, the processes used by its members, and the organizational structure by which it operates. One such example is seen in Dell’s manufacturing of computers. Dell uses a postponement strategy: after customers configure a computer to meet their needs, Dell’s suppliers (each providing well-defined hardware or software modules) are integrated into a virtual team which schedules, manufactures, tests and ships the final product. This process is applied for orders of one PC (to an individual, probably) or for hundred or thousands of units (to a business customer).

Adaptation is a key characteristic that allows customers to configure what they procure from the SBN. While Dell and Cisco are most well-known for offering customized product sets by organizing SBN-based supplier networks, they are not unique. Effective adaptation makes the postponement strategy a reality, in which sellers delay – to the last possible moment – the commitment to produce a finalized product. In an ideal world, this decision is postponed until a customer defines, orders and pays for their product. In the real world, strategies promoting adaptation, and the ability to change and evolve both what you sell and the processes by which you operate, offer what CISCO has called “competitive agility.” Competitive agility is the result of using adaptation to reduce time to market, cost of products, and inventories of unsold finished goods.
3.4 Value

Value is that characteristic signifying the perceived benefit of external agents in establishing relationships with the SBN. This benefit is defined by some in monetary or economic terms, others in terms of time and responsiveness to time-based needs, and others still in terms of relationship factors such as reliability and respect for intellectual property. Being agile in generating and measuring value is the essence of this characteristic.

Value is often considered relative to the production of some transferable token. Traditionally, this token is a good or service, produced by the supplier and transferred to or performed for the customer for payment. Customers perceive additional value in supplier SBNs that provide their tokens consistently, reliably, of high quality, and in a timely response to the customer’s changing needs. All of these traits are certainly valued by customers, but we suggest a much greater value ensues when the SBN migrates from providing goods and services to solutions and experiences.

Achieving this migration requires establishing responsibility for the value the customer will achieve from what they have acquired. When transferring goods and services, the supplier is responsible for delivering those tokens as defined in some formal or informal contractual obligation. Traditional benchmarks for recognizing a good or world-class supplier are those mentioned above (e.g., reliability, quality). Yet, in such relationships the supplier completes their responsibility when the product or service is successfully delivered.

Solutions and experiences are successfully provided when the supplier SBN takes accountability for the outcome the customer is seeking. Selling solutions and experiences is an emerging concept. While many claim to sell solutions, they often mean selling the resources and information necessary for customers to develop the solutions themselves. The SBN that produces value, as defined here, partners (formally or informally) with the customer, with their responsibility completed only when the customer acquires the value it was seeking.

Providing value through solutions and experiences often requires a relationship between the customer and the SBN, which operates over time. Consider a general example where the supplier provides equipment that performs some function in the customer’s environment. In many cases customers have trouble operating the equipment and incur additional cost due to breakdowns, repair, and errors made due to a lack of expertise. A
value-producing SBN may sell the equipment to the customer, and also provide a management contract to operate the equipment and maintain it in the customer’s facility. Effectively, they are selling not only the output of their machines’ processes, but that this output will reliably be available to the customer. One example of this value paradigm shift is seen in the company GMA. GMA in Allentown, PA sells equipment to assemble newspapers to major papers all over the USA. They have discovered that many customers prefer to contract with GMA for both the equipment and its operation in their plants. GMA makes a higher profit from its management contracts (which represent a relationship over time) than they do from equipment sales. Plus, customers value greatly the ability to purchase not merely equipment but a complete solution for their needs. SBNs have the ability to produce greater value by adding to their OEM teams the operations capabilities required to operate and integrate such services with customers.

In the Internet economy (or what has evolved from the “dot com” economy), we see many examples of traditional business reinvented by SBNs providing convenience to their customers through operating in cyberspace. Convenience is a value-based term that reflects the integration of solutions and experience-based sales. Consider Amazon, which reinvented the book business, and now uses their method of generating sales to arm SBNs in many fields to sell more effectively; eBay facilitates the creation of virtual markets; and Google has reinvented the business of selling referrals – all primarily due to convenience.

4. SBN Example

Since 9/11, the United States is faced with the daunting challenge of preventing another major terrorist attack. One of the key challenges is securing its borders to prevent terrorists and “terrorist weapons” (mainly weapons of mass destruction) from entering the States. U.S. Customs is responsible for securing the goods entering the country and is responding to this challenge by building a Smart Business Network. This example highlights a Smart Business Network that is currently forming and illustrates the core concepts and strategic characteristics introduced in this paper. Due to the status of the United States in the world economy, this SBN will affect and include countless businesses worldwide, suggesting that this example is not merely an academic exercise, but rather an important strategic topic.
In 2000, “11.6 million maritime containers, 11.5 million trucks, 2.2 million railcars, 829,000 planes, and 211,000 vessels passed through U.S. border inspection systems” [2]. The vast majority of the containers that entered the United States were not inspected. Several years after 9/11, this situation has not changed much. In fact, if U.S. Customs had to suddenly inspect every single container at all sites in the country, as a reaction to a terrorist attack, U.S. ports would have to be closed for 12 days creating a 60-day container backlog and costing the economy $58 billion [11]. Inspecting every container as it enters the United States is therefore unrealistic and the costs to the economy would be dramatic. To determine which containers are worthwhile inspecting and which are not, U.S. Customs is creating a Smart Business Network. The details are somewhat speculative, but the direction is clearly outlined in [11] and is the basis of this discussion.

Containers are a rather information-less item in the supply chain. Most companies do not know where the containers with their goods currently are or how they are getting to the destination in the U.S. Generally, they only know when their goods will arrive at the target port. For Customs though, this is not enough information to determine whether a container poses a risk and should be inspected or not. The SBN that U.S. Customs is creating is going to create a two-lane approach to inspections. Every member of the SBN will be able to send their containers through the fast-lane, which means they will be virtually uninspected. All containers by non-SBN members will be inspected though with the cost of the inspection billed to the company (around $1,000 U.S. per inspection) and a delay of the container’s departure from the port facilities. Due to these costs, it is to be expected that most companies will want to be part of the SBN.

This SBN requires a significant amount of information integration. As Customs places the burden on the importing companies to provide it with the needed information, these companies need to, for the first time, integrate the information systems of everybody involved in the container supply chain. Every company also needs to send all required information to Customs. As this includes purchase orders, companies will be forced to integrate internal systems, external systems of suppliers and provide all the information to Customs in a standardized format. For example, in a pilot project for trucks, UPS had to integrate three different systems, format the data according to the requests of Customs, and also provide new information that never existed in its databases before, e.g. the passport number of the truck driver [11].
U.S. Customs must be able to trust the importing companies. The system completely relies on the information from the companies being accurate and timely. Any omission, either unintentionally or intentionally, could mean that a container with a “dirty bomb” makes its way into the United States. (Note: A dirty bomb is a bomb consisting of conventional explosives and nuclear material. The nuclear material is not enriched enough for a nuclear bomb, but the nuclear fallout created by the bomb is highly dangerous. A dirty bomb is seen as the most likely device for a terrorist attack and could be hidden in a container.) Each company in turn needs to be able to trust its own employees, all its suppliers and their employees and all other companies involved in the handling of the container. To establish trust, Customs is going to inspect rigorously all involved companies and these inspection practices are already trickling down, being applied by companies themselves to their partners. For example, a supplier for Boeing in South Africa was reprimanded by U.S. Customs on IT security during an inspection, which had the effect that “Boeing now does the same every time it vets a potential partner” [11].

The Customs SBN is full of Network-Node Dualities. Each importing company is a node in the network, but also a network of suppliers and handlers itself (which may themselves be networks of producers, transporters, managers and others). The entire network is truly an overlapping parallel interconnected network as well: the containers themselves are one network, whereas the information flow associated with the containers is a different one. While these networks are distinct in the manner and process by which their contents traverse, they are highly interconnected and inter-operational. For example, should now a container arrive that lacks the appropriate associated information, the container network may be notified and temporarily halted until the container is deemed not to contain any threatening cargo.

The Customs SBN will achieve the capability synergy of securing the border of the United States. No actor alone in the SBN could achieve that. It will also produce value for its member companies. For example, the toymaker Hasbro, spent around $200,000 U.S. on implementing compliance with a Customs pilot project and $112,500 U.S. annually for maintaining it. However its inspection rate dropped from 7.6% in 2001 to 0.66% in 2003, which translated for Hasbro’s transportation of 8,000 containers annually into savings of $550,000 U.S. per year [11].
To remain effective in its long-term goals, this SBN has to be very adaptable. Threats, companies, routes, containers and ports change continually and the SBN needs to keep pace with it all. Last, but not least, this SBN will establish its own identity, which includes: the standards and requirements U.S. Customs will define; the procedures companies will adopt; the way disputes, challenges, non-compliance and other issues will be handled; how new members will be added and current ones removed, and so on. This SBN will also portray an external identity in protecting the United States, which is an important image component for U.S. Customs and also for the companies involved.

5. Conclusions

The maturity of the Internet as a communications tool has fundamentally changed how organizations operate. No longer is it necessary (or necessarily desirable) to amass all necessary functionality and resources into a singular, monolithic organization to achieve success. Now, organizations may be of multiple sizes, physically located across great distances, and yet able to synchronize, communicate, and effectively work collaboratively using the available digital tools and infrastructure. Achieving sustained success in today’s dynamic environment now requires an organization to be agile in its operations and mindset, partnering with other specialized firms as appropriate, and forming transient virtual organizations to meet multifaceted and temporal market needs. The Smart Business Network paradigm provides a framework capable of achieving all of this.

To better understand the nature and composition of SBNs, several fundamental concepts and characteristics are discussed. The core concepts (of Information Integration, Trust, Network-Node Duality and Overlapping Parallel Interconnected Networks) provide an abstract architectural toolset that, when properly implemented and integrated, generates a framework by which an SBN may be formed and thrive in a dynamic environment. The strategic characteristics (of Synergy, Identity, Adaptation and Value) arise from the application of the core concepts, and serve as developmental goals and metrics in gauging the overall “healthiness” (i.e., success, sustainability, growth-capability) of SBNs. These concepts and characteristics have been discussed in detail, and applied to the current development of an SBN by U.S. Customs.
The goal of this paper is to provide the beginnings of a formalism to enhance future discussions on SBN development. As the literature in this field generally consists of use-cases and ad hoc descriptions, we hope that this paper spurs others to continue to develop vocabularies, frameworks and formalisms (through appropriate debate and rigorous analysis) for the purposes of generating more effective, efficient and competitive SBNs. Finally, we have striven to identify and clarify main themes for SBN development, so they may be more immediately applied by executives and others who are actively planning and building SBNs.

References


These proceedings represent the many and interesting papers that have been submitted and reviewed during the three days meeting in 2006. Authors were able to amend their papers based on these reviews and discussions. Where applicable, the rapporteur for each session has included the comments and discussion points. The proceedings report separately on the various group sessions and theme discussions.