A method for B2B process design and implementation

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Abstract

Starting from the practical needs of one case company and assumed scenario of implementing a business-to-business (B2B) process, we explored business process management from business process (re)design viewpoint and from business process support and automation implementation viewpoint.

The main result of our research is a new method for B2B process implementation that we suggest for companies that are modelling abstract business processes and are setting up or intending to set up a Business Process Management System. We did some initial hands-on testing of the method using the ARIS and Oracle toolsets and we evaluated the compatibility and maturity of these tools. We selected the tools based on the case company’s objectives and because they represent the different approaches to business process support implementation: ARIS represents the business-oriented approach whereas Oracle represents the information technology (IT) oriented approach.

We conclude that the method is a good candidate for adaptation in companies, but that further research is needed to validate the applicability area and practicality of the method in real use.

We find the tested tools are stable and mature in their own area, but note that they lack integration and support for synchronization of the models.

Keywords:

business process management (BPM), business process redesign (BPR), B2B process, process implementation, workflow modelling, ARIS, Oracle
1 Introduction

Business process management (BPM) and service-oriented architecture (SOA) are currently hot topics both in information technology industry and information systems research community. Together BPM and SOA are promised to deliver substantial productivity gains and time-to-market benefits for enterprises. However, the standards in these areas are still incomplete, software product families are incompatible and the market is in turbulent state.

Software vendors and Information Technology (IT) consulting firms already tout BPM+SOA success stories, but useful best-practices information is still missing and many companies are waiting for the right moment to proceed into setting up BPM+SOA infrastructure. At the same time business pressure for delivering more flexible IT solutions is constantly increasing.

This pressure was felt also at the OP Bank Group Central Co-operative (OPK), and they decided to participate Helsinki University of Technology research effort concentrating on Business Process Management. This report resulted from a joint research project between OPK and Helsinki University of Technology (HUT) during fall 2006. OPK provided research case information and set the research objectives and whereas HUT conducted the actual research effort.

2 Background and Motivation

2.1 Environment at OPK

OP Bank Group is one of the largest financial segment enterprises in Finland, providing banking and insurance services for both private and corporate customers. OP Bank Central Co-operative is the service development, operations and support centre for the independent banks that form the OP Bank Group. The shorthand name OPK comes from the Finnish name of the co-operative (“Osuuspankkikeskus”).

2.1.1 Software Architecture Background

The idea of SOA has been maturing within OPK for four years. Already in 2002, the vision of the target architecture for multichannel customer service was set based on reusable, business-oriented services that together with "service configuration service" would enable conducting business processes channel-independently.

Over the years, the market has matured and OPK SOA vision has sharpened to include XML-based service interfaces and "process control platform". The business process management systems (BPMS) tools evolution has been closely followed, as OPK has been waiting for the right moment to build the platform and for a suitable business development project to pilot the platform.

2.1.2 Business Processes Modelling History

Simultaneously with the multichannel architecture vision, modelling business processes was recognized as one critical area to be developed and ARIS was selected as the strategic tool for process modelling (IDS Scheer, 2006). Top-level process map was modelled in 2002, and ARIS was used for modelling the systems engineering processes. Actual business process modelling was a slow and uncoordinated effort, resulting only in process fragments modelled from different perspectives.
In 2005, a new "service development process" was introduced. It emphasized coherent modelling of business processes before starting any systems development tasks. Simultaneously, a centralized support organization, “process office”, was established with 12 full-time process modellers.

2.1.3 Bridging the Gap between Business Needs and IT Solution

By the end of year 2005, every new development programme was producing process models and they had proved useful in clarifying the business objectives for systems development effort. During spring 2006, new requirements specification method was rolled-out. One of the main innovations there was the introduction of "system structure description", with e.g. business services distilled from the business process models and assignment of these services to applications.

The system and service structures are modelled in ARIS on a high conceptual level. These architecture models are very useful for guiding projects to reuse existing platforms and service applications. However, the business processes modelled and the services identified serve only as specifications for the design and implementation phases.

2.1.4 Evaluations and Prototypes History

During autumn 2004, OPK conducted a BPM target architecture project, the conclusion being then that it was all too early to move forward due to the immaturity of standards and products (OPK project report, 2004).

During autumn 2005, a potential pilot project was starting and the BPMS market was revisited. After product screening, Oracle Business Process Execution Language (BPEL) engine was selected for proof-of-concept prototyping. The experiences were quite positive, but due to the tight schedule of the project, OPK decided not to invest into the process execution platform at that time. (OPK project report, 2005).

In summer 2006, Oracle and IDS Scheer announced a deep partnership, promising complete process development cycle (IDS Scheer Press release, 2006).

Finally, in early autumn 2006 OPK enterprise architecture unit decided to seriously consider setting up the process execution platform based on Oracle SOA Suite.

2.2 Business Needs

In the following chapters, we illuminate the OPK motivation for this study from different angles, starting from the challenges experienced in practical process modelling and systems engineering work, and concluding with the requirements set by future directions.

2.2.1 Business Process Modelling Related Issues

At OPK, the following challenges have been identified in moving from business process modelling to systems requirements engineering:

- business process models have different viewpoints and varying granularity
- the channel-independent business process models do not help much in defining the actual workflows to be automated
- channel-specific interaction processes are not being consistently modelled

In order to solve these issues, a coherent methodology for modelling business processes is
needed, governing the process modelling phases, model granularity levels and viewpoints. The process modelling methodology needs to be integrated with systems engineering methodology, to avoid overlapping tasks and miscommunication of requirements.

Besides the methodology there is a need for tools that support the methodology and modelling notations used, with clear division of responsibilities between business-oriented modelling tool and IT-oriented design and implementation tool.

An open question is, whether the tools need to be actually integrated, or is it sufficient to treat the business models only as requirements specification level documents, and keep the systems engineering toolset separate.

2.2.2 Process Implementation Related Issues

Proceeding from business process towards implementation involves mapping the process model onto the actual processing units and existing services, giving rise to the following challenges:

- structural mismatch between process models and implementation environment makes it impossible to derive the executable workflow directly from the process model
- the objectives of maintainability and reusability impose conflicting requirements for the design of executable workflows
- how to ensure traceability and consistence between process models and their implementation
- how to support matching of service interfaces to executable workflows and designing interfaces for new services

These issues need to be explored in detail, in order to be able to design a practical process-and-services-oriented systems engineering methodology. However, we feel that solving these issues require a broad enterprise architecture approach guiding process modelling, services management and infrastructure development with shared structures.

2.2.3 Future Directions

Whether business objective is increased productivity or competitive edge, both require business processes re-engineering and automation. In addition, business development cycles are getting shorter all the time, requiring fast business process implementation to enable short time-to-market for new products and services.

The network economy is evolving from transaction portals to providing comprehensive online services, which require full deep integration between business partners in the value chain. In order to be competitive in such an environment, companies must be able to establish automated processes with new business partners rapidly.

These future scenarios emphasize the importance of business-to-business (B2B) standards at several levels: transport protocols, syntax and semantics of business documents, and agreement on business process. The standards utilization enables reusability of B2B solutions. However, it requires management control and discipline to make new B2B partnership implementation a repeatable exercise that enhances the maintainable and secure B2B platform of the enterprise.

2.3 Research Objectives

Trying to tackle all the described business drivers for business process modelling and for B2B process implementation, would be much too wide scope for this study. In this chapter, we
refine our research objectives to an attainable level of ambition.

We intend to enhance the understanding of mapping abstract business process models to executable workflows and designing and implementing B2B processes with the ARIS and Oracle product families. The selected tools further direct the research to Event-driven Process Chain (EPC) diagrams as the business process notation and Business Process Execution Language (BPEL) as the executable workflow language. ARIS has support for other notations, but EPC is the native language of ARIS and it is the modelling language used at OPK.

We will distil our findings into advice for companies planning to set up a B2B process platform and the supporting development procedures.
3 Field of Process Design and Implementation Explored

3.1 Concepts

3.1.1 Business Process Management Concepts

Business Process Management is a field of computer science defined by Van der Aalst et al. (2003) as follows:

“Business Process Management (BPM) includes methods, techniques, and tools to support the design, enactment, management, and analysis of operational business processes. It can be considered as an extension of classical Workflow Management (WFM) systems and approaches.”

However, business process management can be understood as a more general concept, which includes the business development, business process engineering and corporate governance perspectives. At OPK, business process management has been conceptualized as an iterative evolution cycle as illustrated in Figure 1 below.

![Figure 1. Business process management framework (OPK, 2004)](image)

The two background blocks in Figure 1 reflect the profound division of business process management into process development and process control.

Process development covers the abstract “meta-models” created for business process improvement or re-engineering purposes. The process development side is closely related with the business theories, for example the process innovation framework introduced by Davenport (1993) matches nicely with the process modelling and process implementation concepts in Figure 1. On the other hand, the process analysis and process optimization concepts in Figure 1 are closely related with the general process improvement frameworks like Total Quality Management (TQM, e.g. Powell 1995) and Capability Maturity Model Integrated.
A method for B2B processes design and implementation

(CMMI, e.g. Ahern et al. 2004) and also with the business process simulation field represented by e.g. Hansen (1996) and Harrington (2000).

Process control covers the actual business process instances and their flow through the organic system formed by the enterprise, its units and employees together with all the other participating parties. In addition to the process execution of primary product or service delivery processes, it includes the control mechanisms responsible for the process monitoring. Process execution is only partly supported by information technology, but the control flow between actors is more amenable for IT system support. Undoubtedly, this has been one of the reasons for implementing and researching workflow management systems for decades already. More recently, the need and capability for integrating independent information systems to implement more fully automated processes has given rise to the business process management systems.

In this study, we focus on the process implementation part of the business process management framework. In the special case of fully automated business-to-business (B2B) processes, the business-oriented framework and computer science definition of business process management happen to coincide. We will be using process modelling concepts from business theory and process execution concepts from computer science.

3.1.2 ARIS Concepts

ARIS toolset has its background in general business process modelling and manufacturing processes optimization (CIM, Computer Integrated Manufacturing). A.W.Scheer introduced the “ARchitecture of integrated Information Systems” (ARIS) concept in 1992 with the idea of building the link between the business processes and the IT systems supporting them. ARIS framework contains five aspects: organization view, products view, data view, systems view and control view. The process models in the control view bind all the other views together in an integrated modelling repository.

The software product company founded by A.W.Scheer, IDS Scheer AG, has developed a product family around the ARIS framework. The ARIS product family currently consists of four branches: ARIS strategy platform, ARIS controlling platform, ARIS design platform and ARIS implementation platform (IDS/products, 2006). In February 2006, IT analyst firm Gartner Inc. positioned IDS Scheer into the leaders’ quadrant in its Business Process Analysis Tools magic quadrant. (IDS/Gartner, 2006)

In ARIS, process modelling is done using Event-driven Process Chain (EPC) diagrams. EPC diagrams are used to model the abstract business processes of the company for business analysis, the purpose being to provide a presentation of business processes to managers (Mendling, Nüttgens, and Neumann 2004).

The main elements of an EPC diagram are functions and events. Functions are triggered by events, and functions produce events. The control flow of a business process is therefore described by a sequence of alternating events and functions. Alternative or parallel paths can be modelled with logical operators, such as AND, OR, XOR, or more complex expressions. These operators can be used for splitting and joining the control flow. (Scheer 2000)

Although the control flow is the most important aspect for describing a business process, there is a lot of other information, which can be relevant depending on the purpose of modelling. For example the people and organisational units responsible for carrying out a certain function, the output produced by a function, as well as the data flow between the functions. The data, product and role elements can also be attached to the EPCs. (Loos&Fettke, 2001)

EPCs can be hierarchically structured across any number of levels by assigning more detailed EPCs to every function within an EPC. Such a detailed EPC denotes the process that is carried out when the respective function is triggered. (Loos&Fettke, 2001)

ARIS framework contains methodologies for information modelling, requirements
specification, information systems design and implementation (Scheer, 2000). For example, ARIS design platform includes an UML modelling tool for software design and ARIS implementation platform includes a SAP adapter and a SOA designer tool for generating BPEL models and export files from the detailed workflow models in EPC notation. (IDS/products, 2006).

However, the ARIS methodology and tools for creating executable workflow models is still rather immature. In addition, because IDS Scheer does not provide an execution platform, the ARIS methodology is dependent on the interpretations of open standards by BPM engine vendors. There is a clear mismatch between the marketing messages of IDS Scheer and BPM vendors: IDS Scheer positions ARIS implementation platform into an intermediate role between workflow modelling and BPM vendor configuration tool, trying to generate and maintain execution-platform-independent BPEL code within ARIS. On the other hand, the BPM vendors like BEA, IBM and Oracle market their offering as a suite, covering process design, execution and monitoring.

In this study, we explore using ARIS together with Oracle BPM Suite with the intention to provide some insight into the division of tasks between the toolsets.

### 3.1.3 B2B Process Concepts

Literature has several descriptions and names for the automated B2B interaction processes. There is a need to view and describe the processes from numerous viewpoints.

Khalaf calls the description on the highest level of abstraction the business protocol, which is a shared, centrally designed description of the process common to all the participating companies (Khalaf, 2006). The business protocol describes the complete process as the data and control flow between the collaborating companies. Sivashanmugam et al. call the business interaction protocols abstract processes, and define abstract processes as specification of public and visible message exchange between the involved parties, which does not describe the internal behaviour or implementation of the involved parties (Sivashanmugam et al., 2004).

The business protocol is a composition of detailed message exchange processes. In this study, we use the RosettaNet Partner Interface Processes (PIPs) as the message exchange processes (RosettaNet, 2006). A PIP is a specification of a single message exchange process, the exchanged business documents, and the choreography of the dialog (RosettaNet, 2006). The business documents are XML-based, and the PIPs describe the structure of the XML with document type definitions (DTD) or as XML Schema definitions.

We refer to the message exchange processes as public processes. RosettaNet Implementation Framework, Core Specification describes public process as follows (RosettaNet, 2002):

"The public processes are business processes through which partners conduct e-business. Within the context of RosettaNet, these are the partner interface processes that are visible between trading partners. Public processes implement the RosettaNet PIP specifications to exchange standard business documents over standard Internet transfer protocols, as specified by the RosettaNet Implementation Framework."

Besides the business protocols and public processes, the participating companies need to describe their private processes that implement the public processes. The private processes are descriptions of orchestrations, which control and drive the services and applications in the company to implement the functionality described by the public process.

Peltz (2003) defines orchestration as an executable process that can interact with both internal and external web services, and choreography as the tracking of message sequences among multiple parties and sources. In this study, we use the term orchestration to describe the control of execution, and choreography as the description of how all the parties work together.
3.1.4 Process Modelling Concepts

Business process re-engineering hype in business science community during the 1990’s highlighted the importance of visualizing the current and future-state processes by process models in order to facilitate understanding, communication and innovation (Davenport, e.g. pg. 25, 137).

The process models are abstractions of the real world and they always reflect the original purpose of the process modelling. As an example, Kettinger et al. (1997) identified five different purposes of process modelling depending on the focus area: strategy, people, management, structure, and technology dimensions of business processes re-engineering.

Business processes modelling can be divided into different levels of modelling, starting from value chains analyzed by Porter (1992) at the top layer. Value chain models are typically used in process maps, introducing the core processes and the supporting processes of the enterprise. Core- and supporting processes consist of the main processes of the enterprise, which further consist of several major business processes (Scheer 2000). The division into main processes and major processes depends on the viewpoint selected to support the company management needs. The major processes in turn consist of sub processes, which can be divided into activities, which are built from specific tasks (Harrington et al. 2000). All these layers together form the process modelling hierarchy - from the top-level enterprise process map down to the bottom-level activity diagrams.

The tasks at the bottom level of process-modelling hierarchy are atomic in the sense that they can be executed by a single employee or a single information system. In this study, we call the very detailed process models containing specific tasks workflow models. It is only at the workflow level that process models are applicable for information system implementation.

The most important distinctive property between modelling in other areas of information science and process modelling is that many of the phenomena modelled must be performed by a human rather than a machine (Curtis et al 1992).

In this study, we use the term workflow model, when referring to detailed process models that can act as specifications for information system implementation or execution.

3.1.5 Process Execution Concepts

RosettaNet Implementation Framework, Core Specification describes executable process as follows (RosettaNet, 2002):

"The executable processes, on the other hand, are like workflow descriptions represented using basic and structured activities specifying a pattern of execution of Web services."

We use the Business Process Execution Language for Web Services (BPEL) (Andrews et al., 2002) for implementing the executable internal processes. BPEL is an XML-based execution language for long running processes; it provides support for orchestration of Web Services and legacy applications. The BPEL processes are exposed with Web Services Description Language (WSDL) (Christensen et al., 2001). WSDL provides a means for identifying the service instances and describing how they can be accessed by other services via the internet.

BPEL processes are executed inside BPEL engines, which are application servers with BPEL execution capability. Oracle SOA suite contains Oracle Application Server which has a BPEL engine.

3.2 Related Solutions from Literature

We reviewed business process management literature with the goal to find solutions for
identifying public processes in inter-company business processes. We also looked into studies on mappings of different types of process models, and transformation between EPC and BPEL.

### 3.2.1 Design and instantiation of generic processes

Khalaf (2006) presents a three level approach for centrally defining abstract BPEL processes for all partners. She proposes that each partner then implements the abstract BPEL processes independently. We found that the abstract BPEL processes provide help for locating the public process interfaces from the existing business process models. Khalaf also describes the mapping of PIPs to BPEL processes.

Sivashanmugam et al. (2005) notes that current service composition standards are based on the interface descriptions of the participating services. The paper points out that interface description based composition results in rigidity because of strong coupling between the process and the interfaces of the participating services. Sivashanmugam et al. proposes that instead of the service interfaces, the requirements of the processes should be captured by using semantic process templates.

A series of articles by Masud (2003) in IBM DeveloperWorks describes in detail the construction of a BPEL process from a RosettaNet PIP. The article series is a good introduction to the problem of mapping PIPs to WSDL + BPEL.

### 3.2.2 Deriving processes from execution

Kindler et al. (2006) describe incremental workflow mining; a technique for automatically deriving workflow models from the on-going execution of a process based rich information of the document exchange. This is analogous to deriving the executable workflows from the abstract process descriptions we are proposing.

### 3.2.3 Event Driven Process chains

The basic problem in modelling with EPC is that there are no constraints on how to model with it. There is no formal validation or restrictions for what the few elements, events and functions, can represent. Mendling et al. (2005) shows how workflow patterns (van der Aalst et al., 2003) can be expressed in EPC. The workflow patterns help this problem by giving guidelines for authoring workflows in EPC.

### 3.2.4 Transformation between EPC and BPEL

We use EPC for modelling both the abstract business processes and the executable workflows. The BPEL workflows are executable software, while the EPC modelled business processes are abstract descriptions of how the company is perceived to operate or should operate in optimal situation. Mendling and Ziemann describe how to derive graphical EPC models from executable BPEL processes (Mendling and Ziemann, 2005). The article addresses the problem of BPEL missing a commonly agreed graphical notation and aims to work around the problem by providing a transformation from executable BPEL processes to EPC notation. The article chooses EPC notation because it is commonly used for process modelling, and it is familiar to business analysts responsible for validating and re-engineering the business processes.

### 3.3 Theories Applicability Assessment

This study intends to enhance the understanding about mapping abstract business process models to executable workflows in general. The introduced articles provide valuable knowledge to base the methodology on. We have not found previous studies that would take into account the existing models of abstract business processes.

The previously mentioned B2B process design and implementation articles are relevant for the design of executable workflows with the ARIS and Oracle product families. The articles covering EPC give a foundation for modelling workflows in ARIS.
4 Research Problem and Approach

After literature review, we can now position our study in relation to previous work in the related research areas.

4.1 Contribution

There is an abundance of BPM research in information systems science area focusing on the analysis and comparison of the different process modelling notations and implementation languages. However, we could not find any articles describing practical modelling methods.

On the other hand, researchers in the business theories field concentrate on the business development and business process improvement aspects, only mentioning the important role of information technology as an enabler.

Our contribution in this study is to try to combine these two BPM concepts in the specific framework of B2B process design and implementation within a company that has the tradition of abstract business process modelling.

IDS Scheer has developed methods for modelling business processes, for designing information systems landscape that supports the business processes and also for proceeding from process modelling to executable workflow implementation. However, B2B process design and implementation method is missing.

4.2 Research Questions

Based on the research objectives and the conducted literature review, we now formulate our research questions as follows:

- How well do ARIS and Oracle tools support the designed method?

In the first question, we will be focusing on the modelling levels and on the interface between business level process modelling and implementation level workflow design. Practicality of a method depends on how it is applied and on the target case. Because of this, we will present a set of assumptions on the method application situation and environment.

The second question reflects our intention to gather the hands-on experiences on using ARIS tools for process modelling and Oracle tools for execution.

4.3 Research Methodology

This study loosely follows the design research guidelines presented by Hevner et al. (2004).

In the first phase, we analysed the background to identify the business needs and present the research objectives, explored the concepts and conducted a literature study to identify relevant studies in the field of computer science, software engineering and business process management.

In the literature study, we discovered that closely related studies do not yet exist. We also realised that we will not be able to get the expected software in time for this study. To react to this we changed the objective of the study from conducting a software review for a new tool towards creating a methodology for how to work with currently available tools.

In the second phase, we designed a method for the design and implementation of B2B processes. We based the method on our knowledge of existing processes, tools, and system
engineering.
In the third phase, we evaluated the method by using it to design an implement a B2B process based on a RosettaNet PIP.
In the fourth phase, we analysed the experiences and results.

4.4 Research Scope Limitations

We used the OPK case as a basis for setting research objectives and guiding framework for our study. We did not use any case data or real company data, or map real services to our process.
We did not evaluate the execution of produced BPEL processes. The research environment is devoid of real services and real company data.
We do not take into account the practicalities of RosettaNet RNIF compliant implementation and deployment environment (RosettaNet, 2002).


5.1 Guiding Design Principles

We distilled the following principles from research objectives to guide the method design:

- The method should support reuse of existing processes, services and information objects.
- The method should be practical.
- The method should enable the produced models to stay consistent and synchronized.
- The method should hide unnecessary levels of detail.
- The method should not force any role to use several different tools.

5.2 Assumptions

We recognised the following assumptions during the method design:

- There already exists an ARIS process modelling hierarchy of the internal processes of the company, but the models are not necessarily detailed down to the executable workflow level.
- The company already has established process modelling, services management and enterprise architecture cultures and has personnel assigned to related roles.
- The company aims to provide multichannel services, and B2B channel is being built or enhanced with a new business protocol.
- The company already has modelled and implemented channel-independent product/service delivery processes, at least in the extent needed for the basis for B2B process implementation.
- The company maintains a service repository that contains up-to-date documentation about all the reusable services, their functionality, service agreement and service interfaces.
- The implemented internal process interfaces are exposed as web services and
described by WDSL-documents.

- The new B2B business protocol is based on some existing standard, e.g. RosettaNet, that specifies the transport, business documents and process flow.

We designed the method with these assumptions in place.

The first three assumptions arise from the research objectives-setting case company, OPK starting point. The second two arise from the simple basic principle that internal infrastructure should be ready before exposing services to external parties as parts of automated processes. Otherwise, all B2B process interfaces will lead to case-specific integrations that become increasingly hard to maintain as the number of external parties and interfaces increase.

The expected runtime environment for the new executable B2B workflow is shown in Figure 2, designed and implemented with the method we propose from the new B2B business protocol agreed between business partners.

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**Figure 2. Expected runtime environment for the executable B2B workflow**

We have separated the channel- and service-layer BPEL engines to make a logical distinction between the internal- and public services. Services deployed on the channel-layer BPEL engine are visible and accessible to the public, while the services deployed on the service-layer BPEL engine are only visible inside the company. The implemented
B2B workflow is to be deployed onto the channel layer BPEL engine, and the possible internal workflows and services onto the service-layer BPEL engine.
5.3 Method Overview – Process Modelling Levels

Figure 3 illustrates the existing model hierarchy of the company internal processes together with the new B2B business protocol modelling levels. The internal process models on the left-hand-side are assumed to exist, when the need for the new B2B process arises. Then the B2B process specification proceeds from the upper right-hand-corner downwards, down to the executable workflow level.

The development of B2B process integration starts from the agreed business model between trading partners, the new B2B business protocol. The business protocol is agreed between business executives and the message interaction process details are left to be worked out by business-line managers and business analysts of all the participating enterprises. When the necessary details have been collaboratively agreed upon, usually based on some existing B2B standards, they are documented into the public B2B process model. It is the authoritative specification for implementing the necessary message processing solutions by all
of the participating organizations and their IT services providers.

5.3.1 Phase 1 – Semantic matching

Within an enterprise, the implementation of the public service interface is logically planned on a functional level to yield the private B2B process model. During this phase, the company process modelling hierarchy (starting from the top right-hand-corner in Figure 3) is utilized to navigate to the related internal channel-independent business processes. These processes are utilized to locate existing business services and logical flow constructs that need to be utilized in the private B2B process model also. We call this phase semantic matching because in this phase the functionally matching internal processes and services are added to the private B2B process model. In this phase, we determine whether any changes are needed into the logical channel-independent processes and services due to the incorporation of the new B2B channel. Often, in order to be able to support the requirements of fully automated and real-time B2B processes, some re-engineering or fine-tuning of the channel-independent processes is needed.

5.3.2 Phase 2 – Information- and service structures matching

The next step in the method is to verify that the existing channel-independent IT services can support the information and service structures needed by the logical B2B process designed in the previous phase. Therefore we call this phase information and service structures matching. During this phase, the service interfaces are compared against the B2B process business documents and message transfer protocol envelopes in order to find mismatches in information content or service granularity. Note that this matching can be done based solely on the service metadata stored in the service repository – there should be no need to inspect the service implementation documentation or code. The output from this phase is the B2B workflow model. It is the architecture level design specification for the implementation of the B2B process. Note that now we use the term workflow model to denote that this model has such level of detail that it contains only atomic tasks that are executed by a single service, person or application without any intermediate tasks. In other words, the B2B workflow model is concrete enough to act as the starting point for the actual implementation.

5.3.3 Phase 3 – Implementation of executable workflow

All the modelling down to this point has been done in ARIS. Now the workflow model is transformed into platform-independent BPEL form and imported into Oracle Designer for adding the technical implementation details to produce the executable B2B workflow. In this phase, the actual Web Services interfaces are configured into the workflow and the necessary XML document transformations are performed and technical exception handling is added into the workflow.

Please note that the lowest two levels in the internal process models, the workflow models, are not at all necessary for the method to work. Instead, the internal processes and services could have been implemented and documented in some more traditional way, e.g. by java programming and UML models. The necessary assumption is that the services needed by the new B2B process exist, their functionality can be verified and their specific interface definition imported.

In the following chapter, the B2B process modelling levels are introduced in more detail.
5.4 Method Detail: B2B Process Modelling Levels

Figure 4 below shows the right-hand-side of the overview diagram in more detail and describes the purpose of each modelling level and the added information in the models. The model type to be used in ARIS is marked for each of the modelling levels 1-4. On the last level, the workflow model is implemented in BPEL in Oracle JDeveloper.

![Diagram of B2B process modelling levels]

*Figure 4. B2B process modelling levels described in more detail*

Note that we have changed the labels to be more detailed for the last three modelling levels. The methodological idea behind “partnership-type-specific” is that the B2B processes modelling should be done with focus on the reuse of the process models in the same types of partnerships. The B2B process models are not reinvented for each new partner.
In the information- and service structures matching phase, the logical process model is detailed into architecture-level. The activities are split down to task level and each task is assigned to a processing unit type, i.e. human worker role (e.g. branch office clerk) or application system type (e.g. SAP HR). At this phase, also the business-related exception handling is added. The design decisions at this point include for example defining transaction boundaries and compensating transactions for rollback. The resulting concrete B2B workflow model is the bridge between business-oriented logical model (EPC) and the executable BPEL workflow.

In the implementation of executable workflow phase execution related detail is added to the model. For example the roles are replaced with the actual work list systems and related worker profile identifiers, and the application system types are replaced with the actual WSDL descriptors, containing the exact service call interface and also the binding to physical server (e.g. the port address of SAP HR at Helsinki premises). In addition, the technical error handling logic, retry logic, audit trail logging logic, message handling infrastructure integration interfaces calls etc. needs to be added at this phase.
5.5 Method Detail: B2B Process Modeller Roles and Stakeholder Viewpoints

The suggested method includes the modeller roles described on the left-hand-side column of Figure 5 below. For each process modelling level the right-hand-side column lists the stakeholders for whom the produced models contain relevant information.

![Diagram of B2B process modeller roles and stakeholder viewpoints]

The major modeller roles in the method are business analyst and workflow engineer. The business analyst is supposed to have understanding about the business functional logic. The workflow engineer is the technical integration specialist familiar with the services infrastructure and interfaces. The workflow engineer does not need be a programmer, although good algorithmic thinking and XML understanding are absolute requirements.
We also assume that the company has a process and service oriented enterprise architecture approach. The business architect and service architect roles are needed for maintaining the enterprise architecture and supporting the reuse of existing business and technical infrastructure and their coordinated development iteratively.

The stakeholder viewpoints relate directly with the scope and level of detail needed on each level of process modelling hierarchy. It is imperative to maintain the level of detail consistently and it is helpful for the modellers to remember for whom they are producing the models. The stakeholders can also be seen as the accountable owners of the process models, who have to approve the models before proceeding to the next modelling phase.

5.6 Method Phases and Tasks

In this chapter, we take a slightly different and wider perspective into the suggested method, by including the surrounding activities that are necessary in order to be able to execute the designed and implemented B2B workflows. Figure 6 shows the main phases of the method in three lanes:

The middle lane in Figure 6 illustrate the staged detailing of the B2B business protocol into an executable B2B workflow, as described already in the preceding chapters. Here we have added as separate phases:

- Exploring the existing process and workflow models. This is a prerequisite for modelling the B2B private process using existing and new reusable business services
- Testing the executable workflows in a simulation environment. Test all the execution branches beforehand with simulated message flows. In addition, if there are manual tasks in the B2B process, it will be useful to simulate the loads, queue lengths and wait times, so that B2B process parameters can be set at reasonable levels from the start. Setting up the simulation environment requires additional effort, but the services and infrastructure can be worked on independent of the workflow modelling effort.
The topmost lane represents the message infrastructure needed for integration between trading partners. Especially during first B2B process implementation iterations, the B2B infrastructure may be missing or severely incomplete. That needs to be taken into account in the B2B process method. Exploring the messaging infrastructure provides the infrastructure service components and information structures needed for architecture level modelling. In architecture level modelling, the changes needed in B2B infrastructure are specified and afterwards, the changes need to be implemented before the designed B2B workflows can be executed.

Similarly, the existing business infrastructure needs to be explored and enhanced as illustrated by the bottom lane in Figure 6.

Naturally, all the deployments are first done into the system testing environment for validation and acceptance testing before actual deployment into production environment.
6 Method Evaluation

We evaluated the proposed method in a laboratory environment. We did not use descriptions of internal services and only reviewed the outcome BPEL processes and WSDL descriptions. We focused the testing on evaluating the method.

6.1 Testing Arrangements

For modelling the business protocol and executable internal processes in EPC, we used ARIS Business Architect version 7.0.2 & ARIS SOA Designer version 7.0.2.

For the implementation of executable internal processes, we used Oracle JDeveloper Studio 10g, version 10.1.3.1.0 (JDeveloper) (Oracle, 2006).

We did not have previously modelled processes as background information, so we built the processes based solely on the PIP specification.

6.2 Conducted tests

We selected the role of the “Financing Processor” in PIP3C2 “Request Financing Approval” as the public process to be modelled and implemented.

The test included building the following models or processes.

Models built in ARIS:

- Business protocol as E-Business scenario diagram
- Private B2B business process model on logical level as an EPC diagram
- B2B workflow model on architecture level as an EPC diagram
- Platform-independent BPEL model generated from B2B workflow EPC

Workflow definitions drafted in JDeveloper:

- An executable BPEL workflow with dummy services, continued from platform-independent BPEL generated in ARIS
6.3 Test model examples

The following models are examples of the models built in the method evaluation phase. The models are simplified but give an overview of what is added in each phase of the method.

6.3.1 Business protocol

Figure 7 is an example of a business protocol drawn as a B2B scenario diagram in ARIS. The function of the model is to clearly describe the document exchange between the parties and provide a top-level view of how the “Confirm financing request” process is executed, and what are the associated business documents.
6.3.2 Private B2B process model – functional flow on logical level

Figure 8. Private B2B process model – functional flow on logical level

Figure 8 is a highest abstraction level diagram of the internal process. The functions are mapped to the existing abstract business processes and grouped to provide an overall view of the internal process which implements the public process. This model aims to give an overall description of the automated or manual functions needed to process the financing request message. This model is the result of the semantic matching phase.
6.3.3 B2B workflow model – architecture-level structural design

In Figure 9 we add the business exceptions which have effect on the outcome of the process. All the outcomes in this model result in the successful execution of the public process, the aim is to identify the decisions needed for the resulting business document. The result also has effect on how further public processes concerning the same request are handled.

The systems with services are also described in this workflow model. This model is a product of the Information- and service structures matching phase.
6.3.4 Executable workflow

In the implementation phase, we first transform the EPC process model shown in Figure 9. B2B workflow model – architecture level structural design
to a BPEL process using the ARIS SOA Designer. The produced workflow is shown in Figure 10. ARIS BPEL model generated from B2B workflow EPC.

Figure 10. ARIS BPEL model generated from B2B workflow EPC
Then the BPEL process is exported from ARIS and imported into Oracle JDeveloper. The same process as visualized by Oracle is shown in Figure 11.

Figure 11. BPEL model visualized by Oracle

The resulting BPEL process has the correct workflow, but it is missing all the bindings to services, business document descriptions and exception handling.
6.4 Testing results

This testing of the method has value as a sanity check for the phases and their outcomes. The processes modelled are simple and we do not put in any services or exception handling.

The method makes sense as a basis for distributing the tasks into phases and assigning roles to tasks. The reuse of existing processes, services and information objects are taken into account in the process, but we did not test if the ideas are feasible in the testing.

Method is practical, but it is also still a rough outline of what it would turn into if it was used in concrete cases.

The method has a top-down approach for constructing the implementation from the top-level descriptions. Detail is added to the models during the construction, but there is no feedback loop in the method, for keeping the higher level models in synch, for example when details become clearer during the implementation and higher level models should reflect the changes. So the method enables the produced models to stay consistent and synchronized, but it is also naïve towards change imposed from bottom-up.

The method does not force roles to use several different tools, but this has the effect that roles working on models on the upper abstraction levels do not get the feedback from below.
7 Experiences on the Tools Used

7.1 ARIS as Process Modelling Tool

7.1.1 ARIS Business Architect

ARIS Business Architect is a process-modelling tool from the “ARIS Design Platform” suite of programs for business process analysis.

ARIS Business Architect provides a multitude of model types, arranged in five categories of the ARIS House: organization models (roof), product models (basement), data models (left wing), functions models (right wing) and process models (the middle hall) that integrate all the other models. The model types we used in our tests, EPC diagrams and E-Business Scenario diagrams, both belong to the process model types. In real life situations, the other model types would have been used to manage hierarchies of modelling objects used in process models. The roles attached to EPCs would be a part of organization hierarchy, products and/or services could have been attached to the overview EPC, B2B business document contents could be tied into an information architecture hierarchy in ARIS data models.

The model types belong to the built-in ARIS method, which limits the object types that can be used in a model type and gives specific semantics to the allowed connection types between objects. The business analyst using ARIS should know ARIS method very well, in order to select the right model type for each purpose. If model types are selected at random, the imposed limitations quickly frustrate the novice modeller who is used to draw quite freely “box-and-line-diagrams” in Powerpoint or Visio. ARIS is a strong repository-based modelling tool, but it requires dedicated resources to model business processes and to manage the modelling environment.

The meta-model of ARIS is simple, yet flexible, powerful and thus very expressive, allowing very different modelling styles. The ARIS method is fully adaptable by the user organization. On the other hand, also the rigor of modelling semantics depend fully on the user organization modelling style and level of discipline.

For example, the built-in EPC model type is quite flexible, which is good for business analysis and re-engineering modelling purposes, but as such it doesn’t support rigorous detailed level workflow modelling for implementation purposes. However, the user organization could enhance the ARIS method to include, for instance the specialized model types for each modelling layer in the suggested B2B process design method.

We run into the limitations as ARIS method when trying to introduce the B2B message contents, i.e. the RosettaNet PIP schemas as detailed background models for the “data cluster” type objects that are used to represent the B2B messages. The only allowed detail model types for data cluster were “Enhanced ER diagram” and “DW diagram”, and we could not attach the UML class diagrams generated by importing the schema to the B2B message objects.

According to our experiences, we feel that ARIS models should be kept at the logical level, describing the business structures and functional flow and IT architecture structures and logical flow. Managing actual implementation details, like XML schemas and actual service interface WSDL level information does not seem natural in ARIS. In general, XML structures manipulation seemed to be a clear weakness in ARIS.

7.1.2 ARIS SOA Designer

ARIS SOA Designer is part of “ARIS Implementation Platform”, a set of programs designed
and model types for supporting the implementation of automated business processes. ARIS SOA Designer is more like an add-on for ARIS Business Architect than an implementation focused program. It is initially familiar for people who have already used ARIS tools for business process modelling, but it did not prove useful for process implementation. The BPEL editor in ARIS SOA Designer does not allow editing the BPEL code directly like you would expect from a developing environment. The BPEL must be edited graphically and then exported when the code is needed. The BPEL generated by ARIS SOA Designer is generic, but has extensions for naming the attributes, which do not work correctly in JDeveloper.

Initially we tried to model the executable process in ARIS SOA Designer, to be able to handle more abstraction levels of the same process in the same tool. We based this on the idea that by keeping all different models of the same process in the same tool we would avoid synchronisation problems between the models. We found that ARIS SOA Designer’s solution of handling all the elements in the BPEL processes in the same way as in the EPC processes is not feasible for using concrete document type definitions or XML Schemas in the models. ARIS SOA Designer stores the model elements into a database and uses references to the elements in all the models. This is an important feature for enabling models at different abstraction levels to use the same elements, but when creating executable processes very detailed document definitions for business documents are needed, and we could not find a good way to manage this detail in the ARIS SOA Designer. Thus, we chose to do the EPC modelling in ARIS SOA Designer, and the executable process implementation in JDeveloper.

7.2 Oracle JDeveloper Studio as a Process Implementation Tool

Oracle JDeveloper Studio 10g (JDeveloper) is a free Java IDE (Integrated Development Environment) with end-to-end support for developing Java applications and Web services. BPEL support is a brand new feature introduced in version 10.1.3.1.0.

BPEL support in JDeveloper appears as a new “Technology Scope” called Integration. Once he Integration scope is added to a project, the project has support for BPEL related files.

JDeveloper provides both a visual and an XML-editor for BPEL files. The visual editor uses the XML description natively, so both the editors can be used when appropriate, and without synchronization problems. The visual editor supports most BPEL constructs and is a great aid in visualizing the BPEL-XML.

JDeveloper itself is a rich development environment. It includes a powerful XML editing framework, including visual editors for XSL and WSDL, Schema support in the XML editor, and DTD to XML Schema transformation.

We used Oracle BPEL engine contained in Oracle Application Server SOA Suite 10.1.3.1.0 in our study (Oracle, 2006-2). JDeveloper has integration for deployment to Oracle BPEL engine, which supports deploying the BPEL projects directly from the IDE with a push of a button using preconfigured Ant build files.

With a java-developer background using Eclipse as the main tool, the philosophy of JDeveloper was not very easy to grasp in the limited scope of this study. JDeveloper has a lot of assisting tools and support for integration built in, and even though a lot of them seems to work straight out-of-the-box, reacting to problems in the validation and building of projects is difficult for a beginner because of so much automation which imposes rigidity on how things are supposed to be done with the tool.

7.3 Compatibility of ARIS and Oracle Toolsets

Using ARIS as process modelling tool together with Oracle as process implementation tool is possible, but still awkward. There seems to be a wide gap between the intended usage levels of the two tools – ARIS being intended for business process analysis and Oracle for visual workflow programming. The current tool versions do not yet support a smooth process design and implementation method. The most grave weaknesses are the following:
• one-way, one-time transformation from ARIS to Oracle, no support for iterative modelling – design – implementation cycle

• missing common repository for information structures and service interfaces, manual tracing needed

• the graphical outlook of BPEL model is different, confusing differences in visual symbols

A new version of Oracle is scheduled for a release during 2007, which includes ARIS Business Architect licensed and integrated into the Oracle product family as the Oracle Business Process Analysis (BPA) Suite. In that release, Oracle promises to provide a common repository solution for the integration problems between models. (Oracle BPA marketing material, 2006)
8 Discussion of Results

In the following chapters, we assess our findings from different viewpoints.

8.1 Validity of Findings

In this study, we have taken the first step into a new research direction, analysed the problem area and suggested a potentially useful method. However, we have only tested the method, as its designers, for logical consistency, as a thought exercise, and for initial feasibility analysis as a hands-on exercise.

Although we have tried to be objective, without field-testing of the suggested method, we cannot claim strong validity for our results. Also, a really practical method would need to have more detailed description of tasks, inputs and outputs. Actually, we have here suggested only a skeleton for a method that should be first developed further and tested for applicability.

Our findings about tools may be distorted due to the limited testing time and missing training on the intended way of using the tools. Our personal histories of using different modelling and development tools may have helped in some and hindered in other aspects of testing them.

8.2 Generalizability of Suggested Method Approach

The approach in our suggested (skeleton for a) method should be applicable also in other than B2B process design and implementation. The same modelling levels most probably would apply in any process implementation area. However, the levels should be renamed to match the specific area.

We encourage other researchers to adapt and test the five modelling levels concept suggested here.

8.3 Relevance for Other Companies and Different Industries

The suitability of the method for the situation of other companies needs to be validated in future research. However, it is assumed that results will have validity for other companies that aim building consistent multichannel customer service processes.

8.4 Suggestions for Future Work

The problem of locating services and internal processes is not addressed in the method. There is a need for establishing a repository for services, which would include support for mapping of services and semantic matching.

For this study we chose EPC for the business process modelling language because it has also been widely used at OPK for BPM, and BPEL for the execution language because it is becoming a de-facto standard and also supported by the Oracle suite. It would be interesting to consider other languages as well, for example using BPMN to model architecture-level workflows. Then, BPMN should be also used in the workflow implementation tool, in order to avoid too many different notations.

Oracle BPA Suite is Oracle’s reworked version of ARIS tools for modelling the business processes and is promised to provide seamless integration to Oracle specific BPEL. A review of the process modelling and implementation with it is the natural next step after this study.
9 Conclusions

In this study we have suggested a method for B2B process design and implementation. We propose the method to be a starting point to bridge the gap between business-oriented process (re)design and implementation-oriented workflow modelling. However, we have not tested the method enough to guarantee that it is applicable in reality. Validating the practical applicability of the method would require more research and field testing.

We emphasize that the practical applicability of the method is dependent on the concreteness and explicitness of the process modelling approach of the target company. Very abstract business control models created for C-level executives are of no use for process implementation, unless they can be linked to real end-to-end business processes.

Another prerequisite for the successful adoption of business process management systems is appropriately modularized business services that can be invoked from the modelled business processes.

ARIS and Oracle tools we used in this study are both mature products and excellent at what they are meant to do, but there is still a wide gap between the EPC models and the BPEL implementations with these products. They currently only support the most primitive integration: one-way, one-time conversion of BPEL workflow from ARIS to Oracle. This generation of tools does not provide a common language for keeping the process models and their implementation synchronized.

A new version of Oracle is scheduled for a release during 2007, in which ARIS has been embedded as part of Oracle suite and they promise to provide full coverage for business process management cycle. Future research is needed to evaluate the coming Oracle suite and to verify its maturity and practical usability.

BPEL itself as a standard is incomplete and immature, and many open issues and vendor-specific extensions makes committing to use BPEL and Oracle Process Manager a considerable risk. BPEL is best suited for fully automated workflows implementation, service orchestration and service composition.

ARIS is a mature tool and safe selection for process modelling because of its flexible metamodel, sound theoretical framework, long history, adaptability and large number of collaboration partners. On the other hand, ARIS is not a simple drawing tool, but a business development concept that requires long-term commitment from the user company in order to gain full benefit from it. Actually, the flexibility of ARIS which makes it a great business process modeling tool, is at the same time the worst weakness of ARIS from the perspective of executable workflows development. Currently, coupling ARIS with workflow implementation tools requires tight discipline from process modelers. The future Oracle release may provide modeling guidelines and support for process modelers.

We did not handle details on semantic compatibility, but stronger technologies are probably needed for it in the future: processes and services discovery, support in process/service composition, semantic matching and compatibility checking between process model and service definition.
References


