

# **Modeling Processes on Enterprise Level**

## **Some Aspects on the Application of Business Ontologies to Business Processes from End User down to EAI**

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### **Abstract**

Business Process Modeling is about creating a common understanding and documentation of a certain part of a corporation or value chain. This paper explains how existing process knowledge from ERP reference models can be combined with ontologies in order to establish the flexible corporate knowledge pool, that is required to implement global distributed business processes with a service oriented architecture. It is described which process- and ontologies modeling languages such as OWL, EPC, flow charting, BPMN or BPEL are used by the several audiences. Finally we present an impression how we support this problem range with our modeling tool SemTalk.

### **Introduction**

Looking at semantic applications today, there are many interesting projects and some convincing results of the activities of the Semantic Web community. There has been substantial progress in defining and administrating ontologies. What is missing, is a general picture of where to use them. In this paper, we describe a scenario, in which we show several ways, where ontologies help doing daily business. As a matter of fact, daily business usually depends on business processes, so we base our work on the idea of integrating processes and ontologies. We describe a use case and the technology, how this use case can be supported by means of Semantic Web technologies.

Since we cannot find enough data for a World Wide Semantic Web out there yet, we concentrate our work on enterprise semantics and inter-organizational collaboration aspects. There is a lot of potential in Semantic Web applications in these areas, as there is an organizational framework that provides instruments for ontology control.

### **Use Case: Implementing a global CRM System**

Bob needs to implement a new CRM solution in his department as a pilot for a global rollout of that process. After a short review of the current situation, he is getting aware of all the internal and external data sources and data formats that have to be considered. He knows, that most of the users prefer to stay with Microsoft Office and Outlook as their front end tool, but as the company is already using other modules of mySAP ERP, it was decided to implement the CRM component of SAP.

Since process modeling is a common task and most people in his department know how to do it, it is decided to start with a SAP reference process exported from SAP Solution Composer into a Microsoft Visio based process modeling tool. Structure and wording of the process are customized to the organization's needs rapidly by use of the corporate ontology.

From SAP's Enterprise Services Architecture (ESA, [1]) System, which is accessible via the SAP Solution Composer [2], the relevant web services are easily identified and included in the processes. Other non SAP IT-systems are also needed in the process. Thanks to the process model the ROI of the CRM solution can immediately be proven.

Alice belongs to the IT department. She creates a [Business Process Modeling Notation](#) (BPMN, [3]) blueprint of the new business process based on Bob's model, including the technical details such as error handling and the semantic mapping of XML data structures by common ontologies. She is actually refining the work of Bob's group by adding some more technical information, which is needed to make the process executable. After generating BPEL [4] code directly from the BPMN model, the actual systems are connected in Netweaver's XI engine. The BPMN blueprint is used to deploy the solution later on in all international subsidiaries which have slightly different systems to integrate. The Japanese go for their own solution and use Microsoft BizTalk instead of XI. Alice ensures that the business functionality is the same because the BPEL code for BizTalk is created from the same BPMN model.

After using the new CRM system for a while, Bob and Alice detect that company wide streamlined CRM processes are good but not good enough. In order to integrate vendors and customers more tightly into their supply chain, they need a common product ontology, shared by all business partners. Using this ontology, sales and procurement processes will become much more agile and easily adaptable to changing needs.

How can this vision become reality? To answer this question, we will first discuss the interdependency between business processes and ontologies and will then describe in more detail, where and which aspects of a corporate ontology can be useful.

## **Process Models and Ontologies**

Business Process Modeling is about creating a common understanding and documentation of a certain part of a corporation or more general: about elements of a value chain. The resulting model consists of knowledge about processes, products, organizational structures, activities, terminology and IT systems.

This knowledge sometimes is described and published solely for just one new process. More often it must be specified in an already existing eco-system of processes, where business partners, ERP systems and legacy systems are relevant constraints. Therefore it is helpful to be able to map the company's terminology to other wording systems as they are provided by process reference models or public ontologies while creating a new business process.

The resulting formalized knowledge model is most often published in (Intranet-) portals. This may be done visually by publishing static pictures of process models or pictures of ontologies.

It also can be published in a machine readable format to support the following use cases:

- For reuse in other models in order to ensure common terminology
- Annotation of documents and web pages
- Intelligent search, e.g. query expansion for search engines
- Libraries of software components, especially web services
- As is; to be used in applications that understand Semantic Web data formats RDF & OWL [5] (-> MIT's Semantic Web-aware Browser "Piggy Bank" [6])

From a process modeler's point of view the first use case is the most important one. Each element in a process model (activity, resource etc.) may refer to an object in the corporate knowledge base. This ensures the application of the right wording in the process models and supports localization to other languages and culture specific variants.

In other words it supports the semantic correctness of process models. Referring to a common concept guarantees that both processes are compatible. This approach applies Semantic Web's ideas of a shared formal representation of data and knowledge to Business Process Modeling. Activities are composed of ontology concepts and verbs, thus helping users to stick to their corporate ontology while modeling on one hand and enhancing this ontology on the other hand, if the corporate ontology does not provide all necessary concepts. For more details please see our former publications: [On Ontology-based Event-driven Process Chains](#) (2005, [7]) and [Corporate Semantic Process Web](#) (2003, [8]).

The corporate knowledge does not have to be implemented in a single database. It can reside in databases, RDF-triple engines and simply in RDF or OWL flat files. The only requirement is a common URI scheme and the possibility to reference elements in specific ontologies.

Knowledge in general and especially process knowledge is mostly created by teams of specialists, often working together in a common project. In order to make it company wide available, it must be anchored in the company wide process map or ontology. The abstract intersection of those team knowledge bases forms the joined "upper ontology" of the company. Using Microsoft Sharepoint's wording this is a team workspace vs. a portal wide visibility of knowledge.

The upper ontology has the advantage that users, which are not members of a specific team and do not know its terminology, have the chance to benefit from knowledge made explicit by those teams.

The upper ontology is a given set of business terms which are stable and agreed upon inside a corporation and between business partners. This terminology is reflected and often determined by IT systems, especially by ERP systems. It makes sense to use concepts defined by major ERP systems as a foundation for a business ontology. Many reference processes of ERP systems are used as a blue print to implement ERP solutions. The vocabulary used in those processes may serve as a source for common understanding between internal and external business partners.

## **SAP Solution Composer, ESA and how to leverage it**

SAP's Solution Composer currently seems to be the best public available source of business knowledge. It replaces the old component based R/3 reference model with a scenario oriented approach.

*"The Solution Composer helps you visualize, plan, and implement coherent and comprehensive IT solutions that integrate business processes within your enterprise and between organizations. Planning your solution and collaborative processes in advance can help you increase revenue, reduce costs, increase customer satisfaction and improve decision making as quickly as possible.*

*The Solution Composer makes it easy to create and change pre delivered content included in Solution Maps and Business Scenario Maps, as well as access and view Role Maps. Its also an ideal tool for planning an implementation project, and for defining, documenting, and communicating your business solution requirements."* (Source: <http://www.sap.com>)

Importing those process blueprints is the first step in defining new business processes that are to be supported by SAP.

Figure 1 shows an example of such a template, the Opportunity Management process for SAP CRM. “Accept lead” is executed by a “Vendor” and has as output an “Opportunity”. It is shown here using an SAP defined notation.

Business Objects such as “Lead” or “Opportunity” which have a more or less defined meaning in the ERP world, become part of the company ontology. In a company ontology the generic concept “Lead” may have as subclasses “Elevator-Lead” or “Fair-Presentation-Lead”, which might need different business process variants to be handled appropriately.

Please note that this new “Lead”-ontology serves two purposes:

- To make sure that “Accept lead” is somehow related to “Lead” in a process model
- As a source for classifying real leads in a semantic web based company which is using an ontology based CRM system

Activities found in the reference model such as “Qualify lead” and “Accept lead” do not yet relate to a common concept of “Lead”. This should be fixed, if this process is going to be used in a multilingual, reusable context. The concept “lead” for example could get two verbs (or “Methods”) which are “Accept” and “Qualify”. Using some simple inference mechanisms it is then possible to qualify an “Elevator-Lead”.

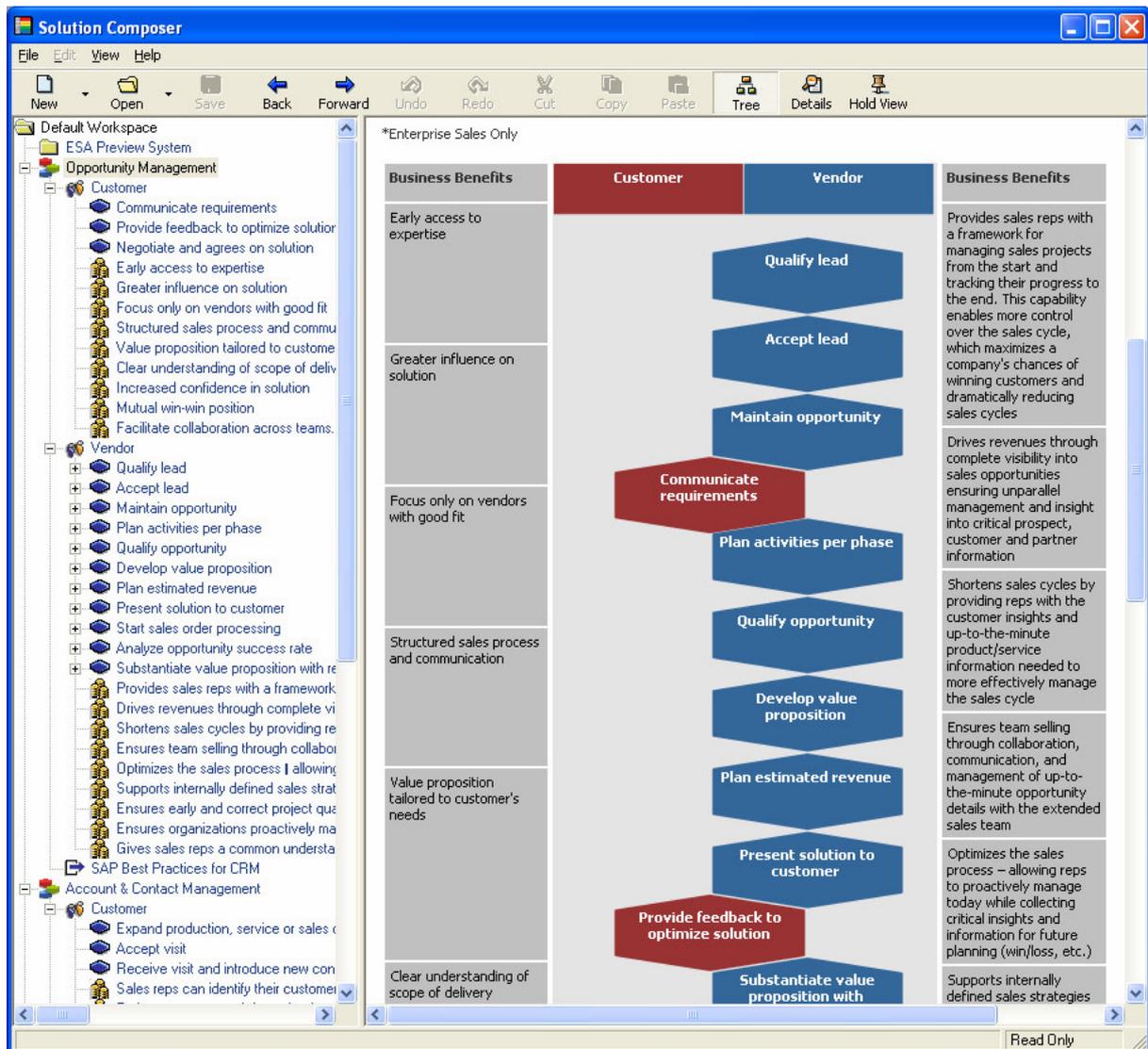


Figure 1: SAP Solution Composer

The Solution Composer contains more than process models. It provides us with the applicable web services for that process:

*“ESA Preview System encapsulates SAP business know-how and industry best practices as a set of service-enabled objects and components. mySAP Business Suite provides the environment and the context where the services are active. The Enterprise Services Preview brings together navigational tools that help you locate enterprise services and understand how they support key business processes*

- *Use Solution Maps to locate services in their business context*
- *Use the alphabetical Service Index to locate services within their functional areas”*

(Source: <http://www.sap.com>)

SAP defines Enterprise Services as web services which provide a certain business functionality more comprehensive than calling a program via an xml based web interface.

*Web services are made of an open standard for system interaction independent of technical architecture. They are self-contained, self-describing and have modular functionality. Once deployed, applications and other Web services can discover and invoke a Web service.*

*Enterprise Services are web services that provide business functionality.*

(Source: <https://www.sdn.sap.com> Enterprise Services Architecture – What It Is, Why You Want It, How You Build It, Ivo Totev, SAP; Kaj van de Loo, SAP [9])

Figure 2 gives an impression of the kind of services which are covered by the ESA system. Each service groups a set of operations, each of them is documented and has a WSDL [10]specification.

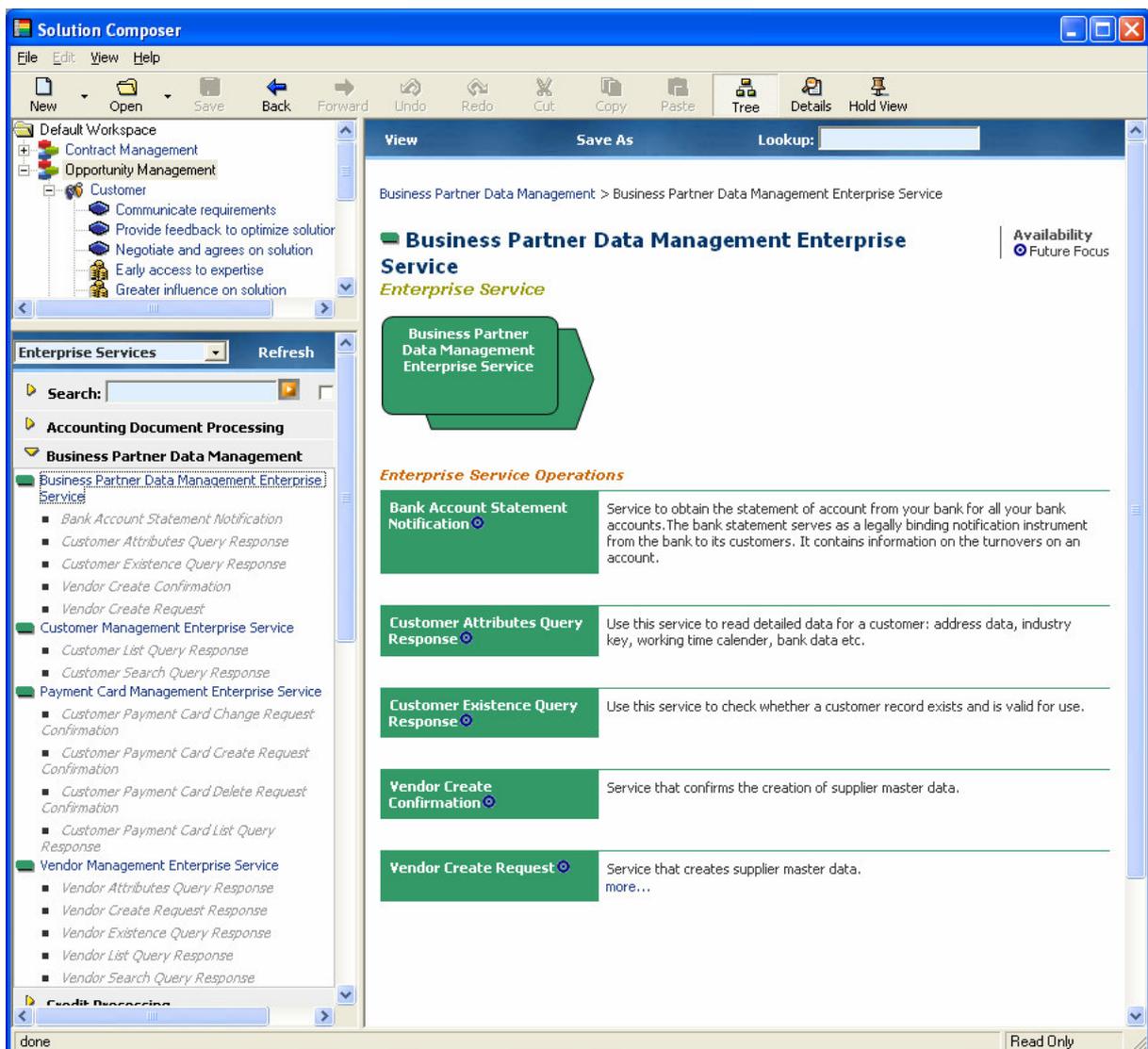


Figure 2: Enterprise Web Service

Similar to process elements enterprise services should be imported into your process modeling tool. Please note that the names of services and operations as they are defined in the ESA repository are not linked to elements of the ontology. No formal definition of the side

effects of a service or its operations is provided by the Solution Composer yet. This has to be done by the modeler himself.

For non-IT users web services are simply another type of element in a process diagram. From the end user's point of view it is not a big difference, if a system is accessed via a web service or not. The process still describes the sequence of tasks which are executed by defined roles. Some of them require data from web services.

Based on this specification the IT group knows which activities need certain web services and the sequence of calls into those services. The next step is to specify a graph of web service calls, omitting all the non IT steps in the business process. This is done using BPMN, which is still a graph based notation. It serves as an abstraction above the programming language constructs of BPEL.

## BPMN for Orchestration

The Business Process Modeling Notation (BPMN) specification provides a graphical notation for expressing business processes. This notation has been proposed by the Business Process Management Initiative. The objective of BPMN is to support business process management by both technical users and business users by providing a notation that should be intuitive to business users yet able to represent complex process semantics. The main focus of BPMN is on systems that interact and interrupt one another, where there are many deeply nested independent, but coordinated, interacting threads of execution.

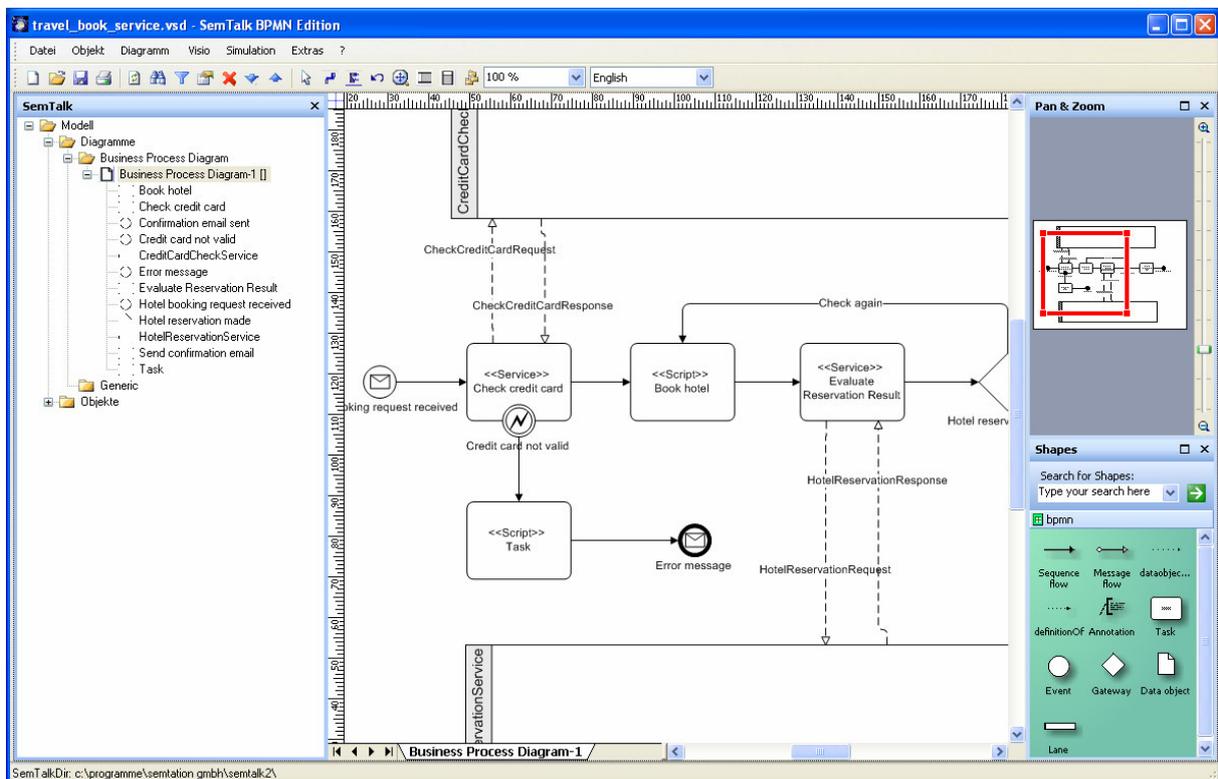


Figure 3: SemTalk's BPMN Editor

BPMN was created with business execution languages and web services in mind. Thus, a BPMN model is characterized by two orthogonal flows. The sequence flow describes the progression of a business process for one of the participating partners. The message flow flows perpendicularly to the sequence flow because it describes the message passing between different partners (information systems). BPMN contains special notations to depict message-based events and message passing between organizations. It also provides adequate notation for elements like dataflow, business rules, exceptions, transactions. BPMN and its direct mapping to computer executable languages like BPEL4WS allows to model specific sections of business processes that are suitable for their implementation as web services and to generate computer code automatically for enterprise application systems like Microsoft BizTalk Server, BEA and SAP Netweaver.

Web Services can be orchestrated on a service-oriented architecture making business processes accessible within private and public organizations and between them.

Given our scenario from above, this means that Bob's business process model, developed by his team in a rather generic notation like flow charting works on the same business objects, that are part of the corporate ontology as Alice's BPMN model. They share the wording of task names and the definition of web services. Alice can see from Bob's model, which service should be applied in what step and can then refine steps to a more technical level where a step in Bob's model represents several steps in Alice's one or several steps in Bob's flowchart are refined to several groups of tasks in the BPMN model, all using the same terminology.

Alice then goes ahead and uses a functionality of her modeling tool to create BPEL from her BPMN model and then starts executing her newly defined process. She might have to add some more rules, but overall her process is already pretty well defined.

Automatically generating BPEL from BPMN is not a trivial task, even if the BPMN specification gives some examples. Most of the BPEL engines perform best, if they are provided with the appropriate programming language constructs rather than simple "BPEL Links". It is about compiling a structured program from a graph structure of function calls. For example "Loops" and "Switches" have to be detected, "Scopes" of error handlers have to be examined etc. It is obvious that not every BPMN process model can be transformed to an executable BPEL code, but you avoid the worst case mapping with BPEL links. Please see our BPMN manual for details and hints. ([www.semtalk.com](http://www.semtalk.com))

Graphical modeling with BPMN does not intend to replace the development environments of the respective vendors as there are Visual Studio or SAP's Process Editor. A screenshot of our graphical BPMN editor is shown in figure 3. Coming from BPMN we can generate only as much as it can be represented in BPEL. Some port mappings or condition expressions in vendor specific languages must be specified in the development toolkits.

We do not see much value in graphical editors for BPEL or even XLANG embedded in BPM tools as they have been provided by some BPM-vendors recently. Graphical BPEL is not well suited to communicate with end users. Developers are much faster with their development environments compared to graphical drawing of code. Also generating BPEL directly from process modeling languages such as EPC or UML Activity diagrams does not make much sense, because these language do not have the syntactical expressiveness of BPMN. For example they often miss explicit constructs for message flow, events and error handling and assignments.

Using BPMN as a source to generate BPEL reduces significantly the effort for developing EAI solutions, if there are many similar implementations to be realized. One other typical use case are e-government processes, since they are defined using often the same legal regulations. Virtually each single implementation has local variants and combines different IT systems [11].

Beyond reducing implementation time, BPMN is used to document the deployments in an abstract vendor-independent fashion. In that sense BPMN is really a kind of silver bullet in this area, because it covers a common subset of terminology in two dimensions: developers as well as the landscape of EAI engines.

Talking about ontologies and web services you might wonder, why we did not mention “OWL-S” [12] yet. OWL-S is more or less the answer of the Semantic Web community to the industry approach BPEL. It contains interesting aspects of defining interface descriptions with ontologies. This part is fully agreed: We map / export / import XML.Schema to any ontology. The other idea of OWL-S is to represent the process itself as an ontology. There are classes defining process steps, sub processes etc. as an OWL ontology. This approach competes with other XML serializations of processes e.g. XPD L without adding many new benefits. It does not tackle the real problem: Connecting the terminology used inside the process descriptions with ontologies as described above. Once the wording and names of process elements are founded in an ontology, the behavior or business value may be judged programmatically with mediators by analyzing the structure of processes, in order to find out, if the web service is “doing the right thing”. For more details on this issue see [Semantic Web Service Processes with SemTalk](#) (2003).

Next step in our scenario: Bob and Alice need to create processes with which their customers and suppliers can easily integrate based on their own systems. This means they want to establish a flexible system to which admitted users can dock their systems while working in their individual process. They realize that they cannot achieve this goal on their own but have to form or join a group of companies that are defining terminology and reference processes together in order to be able to connect their processes when needed. Suppliers need a way to react on orders of their customers and customers need a way to communicate and eventually track their order within the systems and processes of the supplier. If there is a common reference process model using an agreed terminology, the companies who have agreed on it are able to establish flexible communication channels between their systems, which are independent of changes within the respective partner’s systems. There is a project where people try to define things like this, it is called ATHENA (See <http://www.athena-ip.org>)

## **Enabling Enterprises to Seamlessly Interoperate with Others**

Companies operating in the global market often face the need to collaborate with other companies in diverse areas. This necessitates that enterprise systems be able to interact across organizational boundaries in order to facilitate smooth business cooperation. However, there are still significant barriers impeding such collaboration, resulting in unnecessarily high IT costs.

To tackle this problem, the ATHENA project plans to become the most comprehensive and systematic European research initiative in enterprise application interoperability. The project

will initiate an interoperability community, in the form of the Enterprise Interoperability Centre (EIC) in Europe.

### Creating Mechanisms for Smooth Interoperability

- Cross-organizational business processes
- Semantic technologies for automatic and (semi-) automatic data transformation
- Customizable service-oriented architectures
- Economic-impact analysis of interoperability technologies

(Text borrowed from: [www.sap.com/company/research/bpmsi/athena.epx](http://www.sap.com/company/research/bpmsi/athena.epx))

If Bob and Alice define their inter organizational processes based on the results of ATHENA, they are very likely to develop an infrastructure where suppliers and customers of their company can enter and leave and enter again without taking care of changes that might have occurred in one of their systems. This means mapping their terminology to the one of ATHENA and creating their private process with respect to the public process definitions of this project. The public process defines what should be the outcome of the process and what input it needs. It gives an example of how the process should work. In the company the process might work differently, but it has to be able to take the defined input and to create the defined output. Bob and Alice will map their process tasks to ones in the public process and then find out, which data items of their system map to which data item in the public process.

To support Bob and Alice with these activities, we have created a solution that already fulfills a lot of the above mentioned aspects, which we would like to shortly present here.

### Implementation: Architecture of SemTalk

SemTalk [12] is a meta-model driven business process modeling platform, which allows to use and specify multiple process modeling methods such as EPC, PROMET [13] or BPMN. It is based on the most popular diagramming software Microsoft Visio 2003, which is used as a graphical rendering engine. Visio itself has a large collection of graphical symbols, that are used by millions of users for flow charting. Our solution is a plug-in for Visio that defines semantics for those symbols. Especially, it allows to specify which symbols are allowed to be connected to other symbols. Users have the option to extend existing methods or to create new ones from scratch. We are using Visio because it has a pretty intuitive user interface which is well known to a lot of existing users.

The internal data model can be stored in XML flat files or in a database. Since SemTalk provides syntactical correctness of the Visio drawings it is possible to have interfaces with other tools such as ARIS, BizTalk etc.

Multiple modeling methods can be used together for the different audiences in a community. While flow-chart diagrams seem to be a standard for end user documentation, BPMN is the notation to orchestrate Web services. Using the BPMN notation a consultant can represent the business processes as web services, how web services are used to implement activities in a business process and which partners perform which parts of the business process. Models from both communities can share common parts, link to each other but mainly keep the right level of abstraction for their respective target group. Beyond process modeling SemTalk is a graphical editor for the ontology specification language OWL. This functionality is being reused in the process modeling methods.

Technically we are using mainly OWL & RDF as a common exchange format. Other formats supported by SemTalk are XPDL, BPEL from BPMN, export/import of XML schema as well as specific process formats such as EPML or BPMC.

We have created a pretty straight forward Copy&Paste interface from the SAP Solution Composer to SemTalk/Visio. It allows to export the processes to Visio and to continue working with them in an Office environment. This can be seen as a workaround until SAP comes up with a more Semantic Web compliant interface to its knowledge sources. Business processes, Business Objects, Roles etc. can be reused in many processes modeling notations, including a notation for SAP's Look&Feel as well as older notations such as EPC.

## Summary

In this papers we have described how ontologies and process models provide a vertical semantic integration for a given problem. We showed how a common ontology can provide traceability of concepts starting from end users and ending with the orchestration of web services. Reference models of ERP systems serve as a knowledge base. The horizontal semantic integration in a value chain is still an open research issue, but we can expect mainly industry driven standards for example based on SAP's Enterprise Service Architecture.

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