

# Workflow Technologies for a Virtual ISP

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**Abstract:** The eBusiness environment has been undergoing constant transformation in the last decade, creating new opportunities for all kinds of business to be carried out. The IST project VISP (Virtual ISP) is developing a software platform to support the collaboration of small companies in a cluster of Internet Service Providers (ISPs) so that they can provide tailored niche services over the Internet in competition with larger telecommunication companies. This paper investigates the relevant business process management and workflow standards that may be used in the implementation of this software platform. The standards are evaluated and their applicability for VISP discussed.

## 1. Introduction

The eBusiness environment has been undergoing constant transformation in the last decade and is now available everywhere due to the explosive growth of the Internet and supporting Web-based technologies. On-line business-to-business contacts and cooperation with partners is now also feasible for smaller firms using these technologies. They are able to participate more easily and more cheaply in collaborations that were previously dominated by larger companies who had their own infrastructure.

The IST project VISP (FP6-IST-027178) is undertaking work to support the collaboration of small ISPs in “ISP clusters” so that they can provide niche services over the Internet in competition with larger telecommunication companies. The ability to offer value-added services in addition to simple Internet connectivity will enable these ISPs to extend their service portfolio. The services may be tailored individually and can be composed of numerous service building blocks provided by varying members of the cluster. These clusters can therefore only operate successfully if they have an efficient infrastructure and if attractive services can be rapidly composed in a variety of ways to suit individual customers. The ability to collaborate with other partners is only possible if the processes supporting this collaboration are automated. The ISPs therefore require not only effective internal processes but also inter-organisational distributed processes supported by other partners in the cluster.

## 2. Objectives

A main objective of VISP is to develop a software platform enabling the ISPs to collaborate using *business process management* and *workflow* technologies supporting the modelling, specification, deployment and execution of the tailored services. The VISP software platform consists of two major parts: the *modelling and specification platform* supports

service modelling, choreography and orchestration; the possibly distributed *workflow execution platform* executes and controls the service specifications.

This paper describes the results obtained from a comprehensive evaluation of business process management and workflow technology standards that was performed in order to select the appropriate technologies to be used for the implementation of the VISP modelling and specification platform. These standards were compared according to a set of market and technical evaluation criteria that were developed in VISP specifically to assess the applicability of these standards to the VISP work [6]. The results of the evaluation are discussed and the most promising candidates for the VISP platform identified.

### **3. Methodology**

There are numerous business workflow technologies available in this dynamic and constantly evolving area and the task was to select the right combination of notations, languages, mappings and tools appropriate to the requirements of VISP. The criteria used to evaluate these technology standards are therefore of special interest. They can be categorised either as general criteria that position the standard in the marketplace or as technical criteria that decide whether the technology can meet the operational requirements of a VISP cluster. Given the rapidly changing situation with workflow standards, the general criteria are concerned with how mature a standard is and whether VISP can rely on tools supporting a specific version of the specification. The technical criteria vary according to the kind of specification being analysed. For choreography and orchestration standards, criteria such as supported workflow patterns and mechanisms for control flows, parallel flows, complex structures, error handling, role support, timing constraints and extensibility are considered. However, not only the technical details of the technologies but also how the technologies relate to each other, including tool support for interoperability between technologies, were taken into consideration during the evaluation.

### **4. Evaluation of the Standards**

Most of the standards concerning business process management that were evaluated in VISP are introduced either by major industry organisations or by standards bodies, as shown in Figure 1, which is intended to set the context within which the individual standards were selected. In the following sections, the standards evaluated are those from the Process Modelling, Process Choreography and Process Orchestration categories of Figure 1 as these are most applicable to the VISP modelling and specification platform.



*Figure 1: Business process related standards and standards bodies*

#### *4.1 Modelling methodologies and graphical notation standards*

Modelling methodology and graphical notation standards considered to be of relevance to the VISP evaluation of business workflow technologies were analysed as part of the VISP evaluation work. Those of most significance to VISP are presented in this section.

The **Unified Modeling Language** (UML) is a relatively open standard from the Object Management Group (OMG). The current version of the standard is UML 2.0, the adoption of which is nearly complete [5]. UML 2.0 provides 13 types of modelling diagrams that help to capture the structure and behaviour of a modelled system. One type of diagram, namely the Activity Diagram, received particular attention in the VISP analysis. The reason for this is the suitability of Activity Diagrams for modelling dynamic system behaviour and consequently for business process modelling. The UML Activity Diagram supports concurrent or sequential processes and is able to describe parallel behaviours. It uses such important concepts as actor, role, message, activity, data and execution flows.

The popularity of UML with software architects, the very wide support from tool vendors and the ability to model the behaviour of a system makes UML 2.0 a good tool for workflow and process modelling. However, UML is historically more oriented towards software design than to the definition of business processes and very often it is treated by business analysts as too technical and too complex. An important strength of UML is the availability of a metamodel so that it can be used in combination with the MDA (Model Driven Architecture) approach. However, it is important to mention that there is no standardized mapping from UML to executable workflow languages such as BPEL (Business Process Execution Language) or XPDL (XML Process Definition Language) as there is for BPMN.

The **Business Process Modeling Notation** (BPMN) is a standard that was developed by the Business Process Management Initiative and published in May 2004. Since June 2005, responsibility for the BPMN specification has been with the OMG, which presented the OMG Final Adopted Specification for BPMN in February 2006 [4]. BPMN is a graphical notation intended to allow high-level business process design as well as the modelling of more complex business processes and a mapping to an executable language. BPMN is independent of any specific business process modelling methodology. It is fairly intuitive for those business analysts acquainted with the graphical notation of traditional business process flowcharting notations while still enabling more complex processes to be constructed. It goes further than traditional business notations in many respects, not only by mapping to an executable language but also by its support for B2B (business-to-business) process concepts, including public and private processes as well as choreography-type interactions between two business entities. The fact that the specification contains a mapping to BPEL4WS (BPEL for Web Services), which enables BPMN to be used in a tool chain, is of particular importance to VISP. It can also be mapped to XPDL, which makes it a particularly flexible language for VISP. One serious weakness is the lack of a metamodel or mechanism for diagram exchange. The current development of BPDM (Business Process Definition Metamodel) within the OMG should help solve this problem.

In summary, it can be concluded that both BPMN and UML 2.0 Activity Diagrams adequately represent typical workflow patterns [7]. BPMN is considered easier to learn and use than Activity Diagrams and it was designed specifically for business process modelling.

#### *4.2 Choreography languages*

The W3C glossary [8] gives the following definition for the term “choreography”: “A **choreography** defines the sequence and conditions under which multiple cooperating independent agents exchange messages in order to perform a task to achieve a goal state.”

Thus, choreography focuses on the composition of services, an important element in the VISP work. Every standard that is related to choreography has to specify how existing services can be composed and which protocols have to be considered between the participating services during normal execution as well as in error situations. Short-term and long-term transactions together with corresponding compensations have to be considered.

Assume that a choreography specifies the observable behaviour of communicating services. In this case, it is necessary that the choreography refers to the specification of the services as well as to the underlying type systems. If the service specifications and the type systems are compatible regarding syntax and semantics, it is possible to specify directly the control flow and data flow between the services. Otherwise, type mappings have to be introduced. XML (eXtensible Markup Language) and WSDL (Web Services Description Language) are used as a common syntactical framework for the specification of types, services, and choreographies, particularly in the context of W3C specifications. On the other hand, it is not always necessary to know exactly the interfaces of the services that are to be composed. For the definition of a choreography it can be sufficient to specify which messages are exchanged between the services and to ignore the exact signatures of these messages. Thus, a modelling language like BPMN is also an appropriate candidate for the specification of choreographies. Choreography languages are not executable and have to be mapped to templates of executable orchestrations of the participating components.

Former languages like the W3C submissions Web Service Choreography Interface (WSCI) and Web Services Conversation Language (WSCL) have been superseded by the **Web Services Choreography Description Language (WS-CDL)**, published as a W3C Candidate Recommendation in November 2005. WS-CDL is characterized in [9] as “*an XML-based language that describes peer-to-peer collaborations of participants by defining, from a global viewpoint, their common and complementary observable behavior; where ordered message exchanges result in accomplishing a common business goal...The WS-CDL specification is targeted for composing interoperable, peer-to-peer collaborations between any type of participant regardless of the supporting platform or programming model used by the implementation of the hosting environment.*” WS-CDL has not yet reached the status of a standard or W3C recommendation. The final specification can be expected in the second half of 2006. The WS-CDL specification uses WSDL 2.0 as a normative reference. WS-CDL is a powerful choreography language. It allows choreographies to be specified in great detail, which can be seen as an advantage or disadvantage. Choreographies have to be specified in a prescriptive way, thus the derivation of corresponding, executable orchestrations will be quite easy – if the orchestration language supports similar constructs to WS-CDL. The language is quite complex so that it probably needs much effort to learn, understand and apply its concepts.

The ebXML (Electronic Business using XML) **Business Process Specification Schema (BPSS)** provides a standard framework by which business systems may be configured to support the execution of business collaborations consisting of business transactions. It is based upon the metamodel behind the UN/CEFACT Modelling Methodology (UMM). The OASIS (Organisation for the Advancement of Structured Information Systems) Committee Draft ebXML BPSS v2.0.2 was released in January 2006 [2]. BPSS provides the semantics, elements and properties necessary to define business collaborations. A business collaboration consists of a set of business transactions between business partners. BPSS supports two levels of business collaborations, binary collaborations and multipart collaborations. A business transaction is the atomic unit of work in a trading arrangement between two business partners. A business transaction choreography describes the ordering and transitions between business transactions or sub-collaborations within a binary collaboration. BPSS does not depend directly on other Web

service related standards, although support for WSDL is foreseen. BPSS offers support for collaborative processes by means of CPP (Collaborative Protocol Profile).

Table 1 presents the results of comparing choreography languages WS-CDL and BPSS according to criteria defined within the VISIP project.

Table 1: Technical criteria for choreography languages<sup>1</sup>

Technical criteria	WS-CDL	BPSS
Specification of control elements (loop, choice, etc)	+	+
Specification of parallel execution flows	+	+
Supports subflows	+	-
Consideration of end-to-end behaviour	+	
Compatibility with WSDL	+	0
Compatibility with BPMN	-	-
Specification of bindings / endpoint selection	+	-
Supports error handling	+	+
Supports transaction processing	+	+
Supports roles / human interaction	-	+
Formal definition	XSD	XSD
Theoretical basis	Pi-Calculus	n.a.

#### 4.3 Orchestration languages

The W3C glossary [8] gives the following definition for the term “orchestration”: “An **orchestration** defines the sequence and conditions in which one Web service invokes other Web services in order to realize some useful function. I.e., an orchestration is the pattern of interactions that a Web service agent must follow in order to achieve its goal.” Thus, the term “orchestration” describes the flow of communications as a multi-step, long-lived business process from one party’s view. Orchestration languages are used to write these processes in a way that software systems like workflow engines can execute them.

There has been much effort invested in the orchestration language area in the last 15 years. The early work included XLANG from Microsoft and Web Services Flow Language (WSFL) from IBM. These two languages were superseded by the **Business Process Execution Language for Web Services** (BPEL4WS), which was a combination of these two separately developed languages. BPEL4WS version 1.0 was published in July 2002. The **Web Services Business Process Execution Language** (WSBPEL) is a further development of BPEL4WS from OASIS. Version 1.1 of BPEL4WS was released in May 2003 [1]. In September 2004, it was decided to change the name of the draft standard to WSBPEL 2.0 [3]. This change in name and version number reflects the significant and in many cases incompatible differences between BPEL4WS 1.1 and WSBPEL 2.0. Both BPEL4WS and WSBPEL are open XML-based languages for the formal specification of business processes and business interaction protocols. They define an interoperable integration model that should facilitate the expansion of automated process integration in both the intra-corporate and the business-to-business spaces. They support both programming-in-the-large and programming-in-the-small. The general logic of the process can be implemented with the programming-in-the-large approach, which enables business analysts to express their ideas in the most formal way easily without being involved in

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<sup>1</sup> In Tables 1 and 2 the following notation is used: “+” standard satisfies the criterion; “-” standard does not satisfy the criterion; “0” standard partially satisfies the criterion; “n.a.” criterion not applicable.

technical solutions. Architectural problems and programming details are the matter of developers in the course of programming-in-the-small where XPath expressions or even Java code fragments can be used to specify technical details.

The **XML Process Definition Language (XPDL)** is designed by the Workflow Management Coalition (WfMC). In October 2002, the WfMC released version 1.0 of XPDL [11], which replaced the Workflow Process Definition Language (WPDL). Version 2.0 of XPDL, which is backward compatible with version 1.0, was approved as an official WfMC standard in September 2005 [10]. XPDL forms a common XML based interchange standard that enables products to continue to support arbitrary internal representations of process definitions with an import/export function to map to/from the standard at the product boundary. The XPDL grammar is directly related to these objects and attributes. This approach requires that every vendor of an XPDL engine provide an import from XPDL operation and an export to XPDL operation. An XPDL package corresponds to a Business Process Diagram in BPMN. It consists of a set of process definitions that may contain references to subflows, separately defined, which make up part of the overall process definition. XPDL is Web services oriented. An activity in a process may invoke a Web service.

Table 2 presents the technical criteria and results of the evaluation of orchestration languages against these criteria. During the evaluation, it emerged that it is important to evaluate each version of the languages separately.

*Table 2: Technical criteria for orchestration languages*

<b>Technical criteria</b>	<b>BPEL4WS 1</b>	<b>WSBPEL 2</b>	<b>XPDL 1</b>	<b>XPDL 2</b>
Specification of control elements (loop, choice, etc)	0	0	+	+
Specification of parallel execution flows	+	+	+	+
Supports subflows	0	+	+	+
Compatibility with WSDL	+	+	+	+
Compatibility with BPMN	0	0	0	+
Specification of bindings / endpoint selection	+	+	-	+
Supports error handling	+	+	0	+
Supports transaction processing	+	+	-	0
Supports roles / human interaction	-	-	+	+
Timing constraints	+	+	+	+
Quality of service/prioritisation	-	-	+	+

## 5. Evaluation Results

The analysis of the most significant business process management and workflow technologies that are currently available was based on the market and technical aspects of each technology, the technology's applicability for VISIP, and support available for the technology in tools and other products that were also analysed in VISIP. The result of the analysis has led to the following technologies being recommended for use in VISIP:

- BPMN for business process modelling and UML for behaviour specifications and object-oriented software development
- BPMN and potentially UML activities for choreography
- BPEL4WS 1.1 and XPDL 1.0 for orchestration
- WSDL, SOAP (Simple Object Access Protocol) and ASAP (Asynchronous Service Access Protocol) in conjunction with Web services
- Wf-XML (XML Based Protocol for Run-Time Integration of Process Engines) for workflow management

- UBL (Universal Business Language), OAGi (Open Applications Group, Inc) and RosettaNet standards as B2B information models

Products supporting these technologies were also taken into account and a VISP-specific standards stack supporting mappings between the different languages and tools has been proposed (see Figure 2).



*Figure 2: VISP standards stack*

The stack is to be used in VISP as follows. The business process flow modelling, including the corresponding choreography, is undertaken using BPMN or UML activity diagrams. These flows are at a high level and may be decomposed to several levels of detail, as required. Mappings are undertaken, using appropriate tools, to either BPEL4WS or XPDL as orchestration languages. Tools are therefore required that not only support the specification work in a specific workflow language, but that can also map to another language and/or import and export such languages. The standards stack has been produced based on the availability of tools known to be able to do this with the required languages. If not already available, such mappings can be defined in the VISP project itself, utilizing UML based transformation techniques like QVT (Queries, Views und Transformations).

The BPEL4WS and XPDL tools have to be able to retrieve, import and export WSDL descriptions of the required services and the service offered by the specified workflow itself. Accompanied by WSDL service descriptions, specifications of the available data structured as XML schema or in specific data formats such as UBL have to be considered. For the final specification of the executable orchestration, XML-based languages like XPath or mappings to programming languages like Java have to be supported.

## **6. Business Benefits**

The ability to create services tailored to specific customers rapidly and efficiently is a clear business benefit to a cluster of ISPs; indeed, it is a necessary requirement for survival of such a cluster. Offering mere Internet connectivity is insufficient in today's competitive environment and the composition of value-added services based on workflow technologies gives such ISPs considerable business advantages.

The selection of the business process management and workflow technologies is therefore a key element for the VISP software platform. The standards stack that has been selected after evaluation of the most significant technologies is expected to provide a suitable basis for the modelling, specification and execution of workflows in VISP, thus enabling the ISPs to cooperate effectively and the VISP objectives to be realised.

## **7. Conclusions**

This paper provides an overview of available workflow and business process management standards. The applicability of the standards to support the specification and

implementation of business and technical workflows in a cluster of ISPs as required in the VISP project has guided the evaluation process.

The standards stack that has been selected as a result of the analysis both of the standards and the tools supporting these standards is felt to be appropriate for the VISP work. VISP has had to select business process and workflow technologies available in the market today together with current products supporting these technologies and make recommendations based on this availability. The results of the evaluation phase have thus been achieved. The next steps include deployment of such a stack for the VISP modelling and specification platform and an analysis of the advantages and disadvantages that ensue from such a selection. It therefore remains to be seen how these recommendations fare when the modelling and specification platform is implemented. This realisation of the platform is now underway and a tool chain is being built based on the recommendations of the evaluation.

One of the main challenges in this work has been the fact that the standards are relatively new and that it has not been easy to find tools that not only support these standards but which are also able to interoperate in a tool chain. They must also be suitable for SMEs, particularly concerning the cost of such tools for small firms. The main challenges still being met include interoperability of the tools and mapping between languages, currently from BPMN to BPEL4WS, as well as the additional refinements needed to achieve executable BPEL4WS workflows that meet VISP requirements. In addition, the marketplace is very dynamic and so further evolution of the standards and of tools supporting these standards may affect the work being undertaken and lead to certain modifications of the recommendations that have already been made<sup>2</sup>.

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<sup>2</sup> This work was carried out with partial funding from the EU through the IST project VISP (IST-FP6-027178). The views expressed in this paper do not necessarily reflect those of the VISP consortium members. Further information on VISP can be obtained from <http://www.visp-project.org>.