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WORKFLOW TECHNOLOGY SUPPORTING THE OPERATION OF VIRTUAL ISPS

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Small Internet Service Providers (ISPs) face many challenges in the world today. One solution for survival is to collaborate in a virtual cluster providing an attractive range of services that can be rapidly composed and deployed. An efficient software infrastructure is required to support such a cluster. The VISP software platform is designed for workflow technologies and will allow the cluster to model, specify, deploy and execute workflows that support the operation of the cluster and the provision of the tailored ISP services that it is offering to customers.

1 INTRODUCTION

An ISP is an organization providing Internet Protocol (IP) enabled internet and communication services to create efficient and innovative solutions that deliver substantial added value to its customers. This paper discusses the challenges facing a small ISP in the world of today and the rationale behind forming a cluster with other small ISPs so that they can compete in the world of tomorrow. It introduces the operating modes of the virtual cluster and considers the technology solutions that are being adopted so that the ISPs in the virtual cluster can offer attractive, competitively priced services that can be rapidly composed and deployed.

There are several definitions in the literature, not only of a virtual organization (Kürümlüoglu, 2005) (Saabeel, 2002) but also of other types of collaborative networks, such as virtual enterprise, dynamic virtual organization, virtual organization breeding environment (Camarinha-Matos, 2005a). The VISP cluster may not be entirely aligned with these definitions as the services offered by an ISP require a longer-term relationship between providers than products that are delivered to customers with no continuing provider involvement after delivery. An ISP service is provided over months, usually years, and so collaboration between cluster partners also lasts years. Unlike a virtual organization, a VISP cluster is not considered a temporary consortium or alliance but a long-living entity, although partners can join and leave. It is not the objective to create and dissolve clusters according to market demands although they will evolve and adapt to changing market conditions.

This paper is structured as follows. In section 2 the rationale behind the development of an ISP cluster and the operating modes of the cluster are presented. In section 3 the VISP software infrastructure comprising workflow technologies and the VISP software platform to support these technologies is introduced together with the business and technical processes that are being developed as workflows for

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deployment on the VISP platform. Section 4 reports on a validation experiment and in section 5 conclusions are drawn and future work is outlined.

2 WHY VISP?

2.1 The Business Environment

VISP comes from a business pain. A small ISP in a rapidly changing competitive environment with many large, especially incumbent, firms has a constant challenge to survive as a small and medium enterprise (SME) without sacrificing the values held by the company. The ISP market is continually evolving and an ISP has to adapt to meet changing market conditions as well as changing technologies and protocols. The business customers that are being addressed often want services tailored to their specific needs. They also require higher security, higher scalability, higher availability and shorter response times than residential customers as well as greater geographic coverage. No small ISP on its own can provide the geographic coverage and the wide range of complex, specialized services that these customers now want. Small ISPs will have to alter the way they do business to survive, and collaboration with other small ISPs in a VISP cluster is one solution.

Small access ISPs who target business customers are those being addressed in a VISP cluster. The benefits of collaboration that have been recorded in the literature are valid here too (Kürümlüoglu, 2005). In particular, a cluster offers a larger presence in the market. It can create value for ISPs by increasing their attractiveness via a richer offering and so considerably extend their business coverage in terms of possible services. As the number of partners in the cluster increases, the wider the range of services and expertise that is available.

VISP is a term that can be used to represent a range of business models (DIP, 2004). The term is often associated with the reselling of products from a real ISP, where the virtual ISP provides the branding, marketing and sales outlets. This is a different concept from the use of VISP here that refers to real ISPs collaborating in a cluster that behaves as a single business entity providing a wide range of tailored services that can be composed from individual service elements provided by any of the ISPs in the cluster.

2.2 How the VISP Cluster is Organized

The VISP cluster is based on the federation approach; all partners are equals and join in only as much as they want. Each partner is an independent organization with its own resources which it uses to provide services. Figure 1 shows how a VISP cluster may be organized. Two operating modes are foreseen that correspond roughly to the *Internal consortium* (case 2) and the *Partnership* (case 4) types of collaboration in (Camarinha-Matos, 2005b).

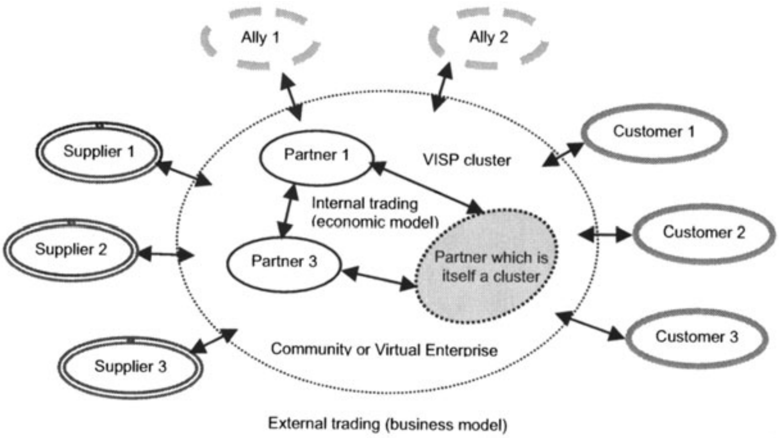

Figure 1 – A VISP Cluster

In the Community operating mode each partner owns its own customers and the cluster is not visible externally. The partner serves its customers and the cluster is used dynamically as a pool of services for subcontracting. The cluster has no assets as these are owned by the individual partners independently of the cluster, but there is a legal agreement defining the cooperation between the partners.

In the Virtual Enterprise operating mode, the cluster is a registered trade organization and all partners share the revenues of the enterprise based on the terms defined in the agreement. The cluster therefore owns the customer relationship, the customer data and the customer transaction. An incoming service request from a customer is dispatched to a partner, which then acts as the cluster mediator and which interfaces with the customer on behalf of the cluster.

3 THE VISP SOFTWARE INFRASTRUCTURE

A virtual organization itself is not a new phenomenon but what is new is the technology now available to support the vision, to overcome the problems and to meet the challenges. The benefits of collaboration in a cluster can only be realized if an adequate infrastructure that can support the operation of the cluster itself as well as the trading of tailored services. The VISP cluster vision is concerned with innovative aspects such as service decomposition and modeling using ontology-based concepts, and business and technical process modeling and workflows. The aim is to provide an automated operating environment that is efficient and agile in providing services to customers, so ensuring the competitiveness of the cluster in the marketplace. The workflow technology approach that has been adopted for the infrastructure is therefore considered key to the success of the VISP vision.

3.1 Workflow Technologies

One of the most significant developments supporting the spread of workflow technologies and business process management has been the emergence of Web services technology and XML in conjunction with expanding Internet use. The loose coupling of Web services enables interoperability between applications on different platforms, and this opens up a range of new possibilities for business models in the ISP market. Integration both within the enterprise as well as between enterprises is not only easier but also cheaper than was the case with locked-in proprietary systems. These developments clearly have an impact on the VISP idea of cooperating roles in a virtual cluster, which requires Internet technologies that automate processes across organization boundaries. Because of the widespread availability of XML and Web services, appropriate technologies have been developed to support such inter-enterprise process systems. This availability is a significant element in realizing the VISP vision.

In the workflow technology area there is a profusion of notations, languages, mappings and tools. Several workflow technologies and associated products were therefore analyzed as to their suitability for VISP's purposes (Eckert, 2006). Other work in the area relevant to the VISP criteria was also considered, for example (Bernauer, 2003), (INTEROP, 2005), (Lippe, 2005), and (van der Aalst, 2003). The BPMN standard (Business Process Modeling Notation, 2006), a business process graphical notation language that can model high-level end-to-end business flows, was selected for choreography modeling with eClarus Business Process Modeler as the tool. BPEL4WS (Business Process Execution Language, 2003), or BPEL for short, models executable business processes based on Web services and was selected as the orchestration language with ActiveBPEL Designer as the tool. BPEL can also be used as a choreography language, as for example in the Astro project (Kazhamiakin, 2004). However, as business analysts prefer to use a graphical notation and as the BPMN standard specifies a mapping from BPMN to BPEL, with tools available to support this mapping, the BPMN-BPEL mapping approach was adopted. The Web Services Description Language (WSDL, 2001) was selected for defining Web service interfaces as it is a widely used standard supported by many tools. Eclipse WTP was the tool selected for editing WSDL files.

Other work in the area of inter-organizational workflows that has been of interest includes that undertaken, for example, in CrossFlow, which based cross-organizational workflow cooperation on contracts between service consumer and service provider, and which used XML but clearly was not able to use the workflow technologies that have been developed subsequently (Grefen, 2000). CrossWork created an architecture for automated workflows in the automotive industry using in particular XRL (eXchangeable Routing Language) (Till, 2005). P2E2 has been developing a platform to support the lifecycle for cross-organizational business processes using the event-driven process chain (EPC) language for top-level modeling and converting the models to XPDL for execution in workflow engines (Walter, 2006). The VISP project is basing its work on standards and open source software wherever possible and has therefore adopted the only currently available standardized mapping between choreography and orchestration languages, i.e., BPMN to BPEL although XPDL was considered a possible execution language.

3.2 The VISP Software Platform

The VISP software platform supports a cluster of small ISPs when modeling, specifying, deploying and executing the tailored services it is offering to customers. It consists of two major parts: the Workflow Modelling and Specification Platform (WfMSP) and the Workflow Execution Platform (WfEP).

The WfMSP is concerned with the modeling and specification of processes that can be deployed and executed as workflows on the distributed WfEP. Three main phases have been identified in order to ensure that an informal textual description of the process that is provided by domain experts for input to the platform emerges as an executable workflow. First, the textual specification provides an informal and then a refined, formalized, specification of the process. Second, the graphical phase takes the textual specification and creates a choreography specification in BPMN, with the required WSDL documents also being defined or imported during this phase. Third, the executable phase takes the choreography specification, maps it to corresponding abstract BPEL orchestration skeletons and refines them to executable orchestration specifications that can be deployed and executed on the WfEP.

The WfEP executes and controls the workflows specified by the WfMSP and it interfaces either directly or through mediation devices with Enterprise Planning Resource (ERP) tools, external applications and network systems and resources. The execution of VISP business processes relies mainly on interactions with the partners' ERP systems and global repositories while the VISP technical processes interact with the network and system components. The workflow engines are the coordinating points of the WfEP and are responsible for executing the workflows. Interoperability between workflows running on diverse workflow engines will enable partners in the cluster to manage their workflows so that they can interact with those of other partners.

3.3 VISP Cluster Processes

Cluster processes are being modeled, specified and executed as workflows of activities in both the business and technical domains in order to cover all service provision related activities. Workflows are needed to operate a complex assembly of resources under the control of the independent partners. They will support cross-application processes, transfer each activity to the adequate resource for manual or automatic execution and deliver the final services. ISP services are continually evolving and so the corresponding workflows need to be specified and implemented in an integrated and standard way so that when a service is modified, the implementation is minimal and automated as much as possible.

The VISP project is providing a consolidated set of business-related workflows able to deal with trading aspects in a dynamic cluster of cooperating partners. The workflows also support the functioning of the cluster and its ability to attract and manage new partners. A set of business processes is being developed using standardized processes wherever appropriate, such as those in the eTOM Business Process Framework (eTOM, 2005) and the OAGIS specifications together with their associated WSDL (OAGIS, 2006). Many specifications, however, assume bilateral relations between partners, often in buyer-seller roles, whereas VISP also requires multiparty business collaboration processes.

A technical process in VISP is any process that interacts directly with network elements. Technical processes cover all technical activities related to the lifecycle of an ISP service in order to instantiate, commission, activate, deactivate and decommission the service. Further administrative activities such as testing, technical location transfer, suspend and resume are also expected to be included. A major challenge of the work is to provide formalized workflow specifications of today's manually executed technical processes to be able to process them automatically in a standardized way as is possible for the business processes mentioned above. Figure 2 shows how the various processes relate to each other.

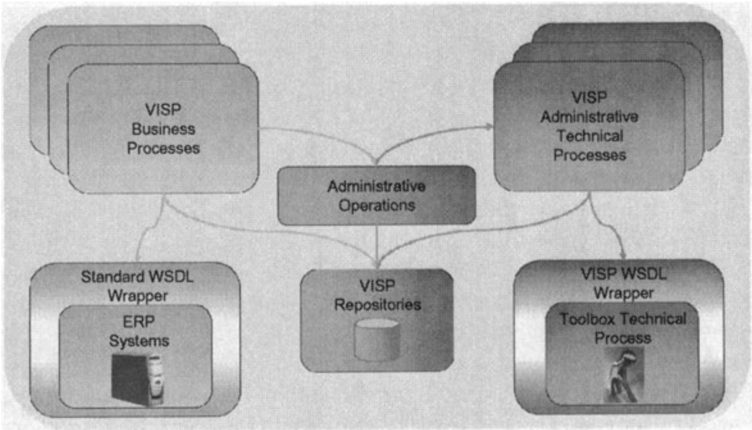

Figure 2 – The VISP Business and Technical Processes

4 VALIDATION

An approach called *goAhead* was undertaken to validate the individual components of the WfMSP as well as the functioning of the platform as an integrated whole. The descriptions of ISP services, the supporting business processes and corresponding technical processes interfacing the service infrastructure required for a typical VISP scenario were developed and refined as they passed through the individual modeling and specification phases. The scenario selected was concerned with the lifecycle of an instance of an ISP service, VoIP, which was considered a typical VISP scenario in that it includes a customer request being received by the VISP cluster, the preparation, negotiation and conclusion of a sales contract, the commissioning, activation and operation of the ISP service and finally its termination.

goAhead was a valuable exercise that enabled several technical details about the individual tools comprising the WfMSP platform and their interoperability to be clarified. It not only validated and refined the functional architecture of the platform but also resulted in an extensive VISP-related evaluation of the selected tools and implementations.

The validation exercise has led to further work aimed at resolving the issues that arose. One issue, for example, concerns the use of asynchronous versus synchronous communication. Many processes are of long duration with execution times in the order of weeks, and often including both manual and automated tasks. For synchronous communication, a BPMN client is modeled as a task of type "service" whereas for asynchronous communication it is modeled as two tasks of type "send" and "receive". The WDSL also has to be modified for asynchronous communication, especially the definitions of "port types", "partner link types" and faults. In synchronous mode the server provides an interface consisting of operations with input, output and fault messages, whereas in asynchronous mode the server provides only operations with input parameters. In asynchronous mode the client also has to provide a call-back interface with operations that explicitly expect responses and faults as input parameters. In BPMN a corresponding exclusive, event-based gateway has to be introduced to separate replies and faults. Although both communication styles can be supported, the modeler has to be aware of the different approaches when deciding which style is appropriate. Interactions with humans also need to be taken into account and many of the processes were redesigned explicitly to reduce the number of such interactions in any one loop.

It was found advisable to establish project-wide conventions for mapping from BPMN, a graph-oriented language supporting processes and sub-processes, to BPEL, a block-structured language. Based on the experience gained in *goAhead* together with other work undertaken in this area, such as (Ouyang, 2006a and 2006b), a set of "best practice" BPMN patterns was defined that map to "good" BPEL code. Conventions for parameter passing also had to be defined as this affects both the WSDL specifications and the BPMN models. Consistency is important in several areas, for example, in ensuring that parameters requested in a bottom-up approach are provided in the corresponding top-down approach. It is also necessary to ensure consistency in error handling mechanisms and compensation activities between the WSDL, BPMN and BPEL models by introducing a common format for all fault messages. Another important requirement resulting from *goAhead* was the development of a consistent information flow for the whole system that connects both the business and technical areas. The resolution of these and other issues are now being input into the next phase of the project work.

5 CONCLUSIONS

The work presented here is a first step towards a long-term vision where workflows enable efficient and seamless collaboration between partners in a VISP cluster so that they can remain competitive in the marketplace. Now that the various components of the platform have been validated in a small experiment, the next phase comprises further work on the specification of workflows and the realization of the architecture to support the workflow specification and execution on a wider scale.

Many of the tools are new and the technology standards are still in flux, so solutions to various issues are not available and have to be created within the project itself. The adoption of workflow technologies to support the automated operation of a cluster of small ISPs in their business is therefore research work that is in progress. There are many challenges in several areas that are being resolved as further experience is gathered. Ongoing work should therefore enable the VISP project to contribute to knowledge about how workflow technology can support virtually organized collaboration.

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