BUSINESS AND TECHNICAL WORKFLOWS FOR E-BUSINESS IN A VIRTUAL CLUSTER OF ISPS

Jane Hall and Klaus-Peter Eckert

Fraunhofer FOKUS, Kaiserin-Augusta-Allee 31, 10589 Berlin, Germany

Abstract: Although workflow technologies have existed for some time, their true potential is only now being unlocked with the emergence of Web services technology and XML in conjunction with expanding Internet use. There has been extensive support for Web services and the standards have matured sufficiently for widespread adoption, replacing proprietary standards for interfaces and data that hindered the integration and automation of business processes, especially between partners wanting to cooperate in a virtual organization. This paper discusses the application of workflow technologies in supporting the e-Business of small Internet Service Providers (ISPs) collaborating in a virtual cluster. Not only business processes but also innovative technical processes are being executed as workflows in the marketing, deployment and operation of tailored ISP services. A scenario depicts the actual processes used and illustrates how the software being developed supports e-Business for ISPs collaborating in a virtual cluster.

1 INTRODUCTION

An ISP here is a small firm providing Internet and communication services to business users, themselves mainly small and medium enterprises (SMEs). e-Business is of direct concern to these ISPs for in the volatile and challenging marketplace of today it is imperative for them to improve their efficiency, to reduce their costs and to automate the selling and provisioning of the services they offer if they are to survive. For e-Business to be successful, full advantage must be taken of the technologies allowing open interoperability and supporting cross-organizational cooperation.

This paper discusses the use of workflow technologies to support a virtual cluster of small ISPs in marketing and delivering services to customers. The research has involved an investigation into how workflow technologies could be used in this context, whether this was a feasible objective, the challenges and issues involved, and how a workflow platform could be designed and implemented to support the objectives. Many of the issues are generic and applicable to many areas, they are however discussed in this paper within the framework of small ISPs collaborating in a virtual cluster. This paper illustrates some of the main ideas and issues in developing a workflow support system for ISP collaboration and in particular highlights an innovative part of the work by showing how technical processes that have been carried out manually by ISPs can be automated using workflow technologies. Only by using such automated processes can small ISPs hope to remain competitive and agile in the marketplace of today and the use of workflow technologies here can demonstrate their potential in such applications.

The structure of this paper is as follows. First some context is given to the rationale behind a virtual cluster of small ISPs. Then the application of workflow technologies to support the operation of the cluster and the collaboration between cluster partners in marketing and deploying services are discussed. The workflow techologies selected and the platform for modeling, specifying and executing them are presented. The business and technical workflows developed for running on the platform are examined. An e-Business scenario is outlined to show how the VISP software infrastructure is being used for marketing and deploying composite ISP services. The work is being carried out within the European IST project VISP (IST-FP6-027178) and conclusions are drawn on the experience gained in the project of utilizing workflow technologies for ISP e-Business.

2 RATIONALE FOR A VIRTUAL CLUSTER OF ISPS

The ISP market is changing rapidly, is quite volatile and very competitive. A small ISP lacks financial resources and has few personnel, which means it cannot cover all areas but does have expertise in specialized areas. It offers a limited range of services and so cannot cross-sell additional services to existing customers. No small ISP on its own can provide the geographic coverage and the wide range of specialized services that customers are now requesting.

Collaboration enables individual business entities to pool resources and competencies to provide value-added products and services (Camarinha-Matos, Afsarmanesh, 2006). The benefits of collaboration in virtual organizations generally are relevant also for small ISPs (Kürümlüoglu et al., 2005). A solution for a small ISP is therefore to form a virtual cluster with other small ISPs for e-Business purposes. In this way, a greater variety of services can be offered as an ISP can integrate its own services with those of its partners in the cluster, extend its geographic coverage and become more visible in the market. As customers are requiring increasingly specialized services, often for a market of one, tailored services can be offered by the cluster to its customers by composing new services from the different services offered by various cluster partners.

The services offered by ISPs require a long-term relationship with the customer as they are provided over months or years. Unlike other forms of virtual organization (Camarinha et al., 2005), a VISP cluster is therefore intended to be a long-living entity, although partners can join and leave. Two operational modes are envisaged for the cluster. The Community mode is where 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. In the Virtual Enterprise mode it is the cluster that is visible to the customer and the cluster owns the customer relationship, the customer data and the customer transaction. When a customer makes an enquiry about a service in this mode it is sent to one partner, which communicates with the customer on behalf of the cluster. The cluster is a federation of independent partners collaborating in a decentralized manner to conduct e-Business. Each partner is a separate entity that joins in the collaboration to the extent that it wishes.

3 WORKFLOW TECHNOLOGIES

Workflow has been defined as "the automation of a business process" (Workflow Management Coalition, 1999). Ever since the existence of widely available computing power, there have been numerous developments aimed at automating and streamlining the activities in a business process in order to improve the efficiency of the organization, both internally and vis-à-vis other organizations (van der Aalst et al., 2003).

A major objective of the VISP project is to develop an innovative software platform enabling a cluster of small ISPs to collaborate and operate as a single business entity using workflow technologies to support the dynamic implementation and provisioning of tailored services. The provisioning and operation of ISP services by cooperating cluster partners requires the introduction not only of business but also of technical workflows in the cluster. However, little work has been undertaken on automating the activities in a technical process and it was one of the research topics to undertake work here so that technical processes could also be automated.

Workflow technologies are being adopted to provide the software infrastructure required by the cluster when undertaking e-Business transactions both with customers and between the partners themselves. Partners in the cluster can use collaboration-based process models to describe their cooperation. A workflow will specify how the individual roles participate in an end-to-end process. These processes are modeled as workflows using formal languages in order to be deployed and executed on distributed workflow engines.

There has been extensive support for Web services and the standards have matured sufficiently for widespread adoption, especially between partners wanting to cooperate in a value network (Keen and McDonald, 2000). Integration both within the enterprise as well as between enterprises is not only easier but also cheaper. These developments clearly have an impact on the VISP idea of cooperating roles in an SME cluster, which requires technologies that automate processes across organization boundaries. This availability is a significant element in making the VISP vision a reality.

Work that had been undertaken in the area of workflows, especially between organizations, could be used as a basis on for the work in VISP for the ISP service domain. This included projects such as CrossWork, which was concerned with cross-

organizational processes in the automotive industry (http://www.crosswork.info); CrossFlow, which investigated workflows in dynamically formed virtual organizations (http://www.crossflow.org); and Astro, which has been developing tools to support distributed processes during their lifecycle (http://astroproject.org).

A top-down approach is being adopted using workflow technologies. The high-level process can be recursively decomposed into sub-processes until the required level of detail is obtained for execution on a workflow engine. Various modeling languages were available and an investigation was undertaken to select those most appropriate for the VISP work (Eckert et al., 2006). BPMN was adopted as a modeling language for the high-level business and technical process modeling (BPMN, 2006). It is a standard containing a standardized mapping to BPEL4WS, or BPEL for short (Andrews et al., 2003), and it was felt that its graphical notation is more intuitive for non-IT specialists acquainted with the graphical notation of traditional business flowcharting notations. Despite the weaknesses and deficiencies of BPMN (Wohed et al., 2006), it was available on the market in tools complying with the standard at the time of language and tool selection for VISP. The 'ideal' solutions were not available and a pragmatic decision was to select a technology that seemed to have potential and was suitable for VISP's purposes.

The BPMN flows are at a high level and may be decomposed to several levels of detail but they remain in BPMN. Mappings from BPMN to BPEL according to the standard are then undertaken and so tools are required that not only support the specification work in a particular language but that can map to another language and/or import and export such languages. BPEL also has its strengths and weaknesses (Wohed et al., 2003), but is in widespread use for implementing workflows. It was selected as it met the VISP requirements in the area of workflow technologies and also because the only standardized mapping was from BPMN to BPEL. The tools selected for these languages were also investigated and selected on the basis of their suitability for VISP aims in the first phase of the project as well as their adherence to the standard specifications of BPMN and BPEL.

In the last year both standards used in VISP have been significantly improved. OASIS published version 2 of WS-BPEL (BPEL, 2007) and several big IT companies proposed an initial submission of BPMN 2.0 (BPMN, 2008) to OMG. BPMN 2.0 will comprise standardized mappings to WS-BPEL as well as to the emerging standards for human interaction, BPEL4People and WS-HumanTask. Additionally the submission introduces a standardized XML-based exchange format for BPMN models, which was lacking in the previous version.

During the lifetime of the VISP project, most vendors of BPEL development and execution tools have migrated from BPEL 1.1 to WS-BPEL 2.0. Because the expressiveness of WS-BPEL and the number of built-in functions increased, it became an option to use the new version of the language and supporting tools. In this situation, the mapping chain has to be extended from BPMN to BPEL 1.1 and then further to WS-BPEL. Theoretically both mappings cannot be fully performed automatically. A mapping from BPMN to BPEL is only possible for a subset of BPMN models, thus not every valid BPMN model is "BPEL-valid". Additionally not every BPEL process can be mapped to a WS-BPEL process. Fortunately the selected tool supports a best-effort mapping that works for most specifications and requires only minor manual improvements.

3.1 VISP Workflow Platform

As the VISP project is basing its software infrastructure on workflow technologies, the software platform that it is developing will allow the cluster to specify, model, deploy and execute workflows that support the operation of the cluster and the provision of tailored services to customers. This software platform consists of two major parts. The Workflow Modelling and Specification Platform (WfMSP) is designed to support service and workflow specification, modeling, choreography and orchestration. The Workflow Execution Platform (WfEP) executes and controls the workflows (see Figure 1).

Informal textual descriptions provided by domain experts and following Cockburn's style of writing use cases (Cockburn, 2001) are the primary input to the WfMSP. They have to be formalized, first as BPMN models, then as abstract BPEL skeletons and emerge as an executable workflow that can be deployed on the WfEP. The workflow engines are the coordinating point of the WfEP that are responsible for executing and controlling the workflows specified by the WfMSP. The WfEP interfaces either directly or through mediation devices with partners' ERPs and with network and system components.
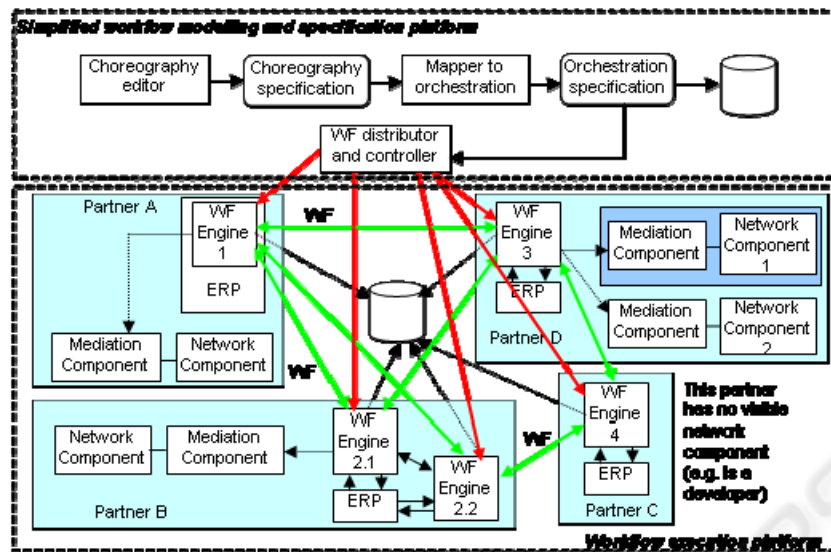
Figure 1: The VISP workflow platform.

3.2 VISP Workflows

Workflows are being developed in the VISP project to support the provisioning and operation of services offered by the partners in a VISP cluster. Processes are being specified, modelled, and executed as workflows of activities in both the business and the technical domains (see Figure 2).

A set of business workflows is being developed within the project able to deal with business processes in a dynamic cluster of partners and therefore providing for multilateral relationships and not only for binary relationships. These use standard processes where available, such as those from the OAGIS specifications together with their associated WSDLs (OAGIS, 2008) and are also based on the use cases produced as part of the requirements work undertaken within the project.

The technical processes in VISP are those that interact 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 being included. The project is providing formalized workflow specifications of technical processes that are currently manually executed in order to be able to process them automatically in a standardized way, something that has been possible for business processes but not so far for technical processes.

The technical processes are categorized in two groups, the Administrative Technical Processes (ATPs) and the Toolbox Technical Processes (TTPs). The ATPs perform all operations required to support a single ISP service instance lifecycle and to interface them to the corresponding business processes. They administer an instance of an ISP service and are invoked by the business processes. They can be defined and used without the VISP system and an adapter to the VISP system has been developed that maps and forwards all the necessary information stored in the VISP repositories and workflow engines to the ATPs and TTPs.

The TTPs act directly on low-level Web services found in the mediation servers of the various network elements. They usually contain just one atomic operation to be performed on one low-level Web service. They are invoked by the ATPs and are specific to a service instance type.

The relationship between the business processes, ATPs and TTPs can be seen in the service instance lifecycle where business processes are responsible for handling generic operations on composed services, or service sets, for example, "instantiate a service set". Business processes first invoke the trading mechanism and determine the cluster partner that is best suited to provide the "Simple Call Service" VoIP. Then they invoke ATPs to perform operations on each of the service instances in the service set, in this case "instantiate Simple Call Service". Each ATP can call directly one or more TTPs to carry out atomic administrative operations on service instances.
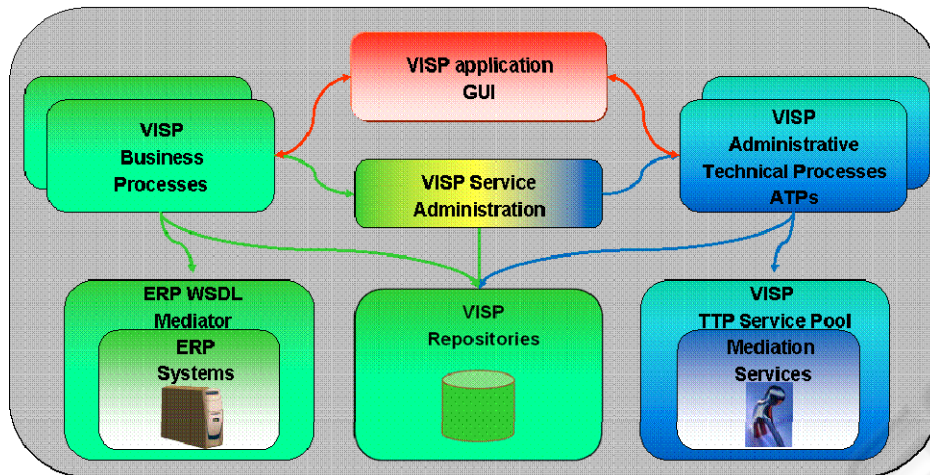
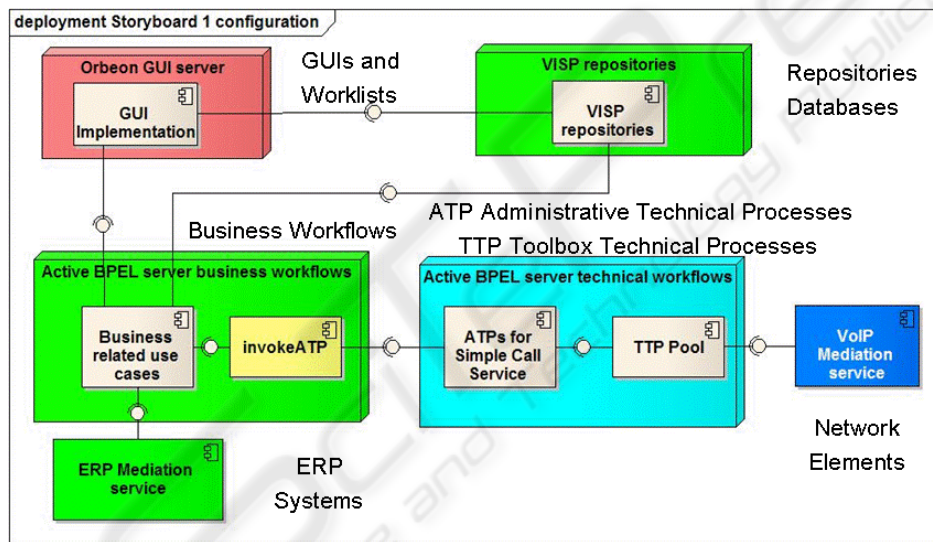Figure 2: Business and technical processes.

Figure 3: Overview of the VISP components.

In this example, the ATP invokes the TTP that initializes the new user account in the network infrastructure. The TTPs help to isolate the upper layers of processes from any changes to the WSDL description as only the TTPs using the specified WSDL file need to be changed and not the ATPs themselves (see Figure 3). The parameters needed to invoke the TTPs are either stored in the VISP repositories or can be retrieved from the ISP's employees, for example from network engineers, utilizing the VISP internal worklist management system.

The technical processes are intended to automate as much as possible of what network engineers have been undertaking manually to date. The need to be efficient and competitive means that small ISPs can

no longer have their scarce human resources tied up in time-consuming tasks. The VISP project is therefore taking the technical knowledge of network engineers, preparing textual specifications of the steps involved in their work, modeling these steps in BPMN, mapping this to abstract BPEL, refining to executable BPEL and then running on the partners' workflow engines.

Technical processes have not been standardized and so this work constitutes an innovative aspect of the project. The intention is to automate where possible not only the business but also the technical aspects of provisioning and delivering ISP services.

This can save scarce human expertise for more complex tasks and thus enable ISPs to be more competitive and efficient in the marketplace.

4 REALISING E-BUSINESS WITH WORKFLOW TECHNOLOGIES

This section introduces the implementation of the VISP software infrastructure and the specific issues encountered. Implementation work is being carried out incrementally, with the first release concerned with how a simple VoIP service can be sold to a customer and how a VoIP system already accessible through Web services can be controlled from the VISP software infrastructure.

The e-Business scenario comprises the sale and provisioning of a VoIP service for a customer and it demonstrates how the various parts of the software infrastructure are utilized to support this. A prospective customer enquires about the 'simple call service' VoIP via a cluster communication channel and a sales representative from one of the partners is selected to process the customer's request on behalf of the cluster. The sales representative checks the customer in the cluster's Consumer Directory and if not already in the repository, registers the customer there. This requires infrastructure support to search the Consumer Directory and, if necessary, to update it with the prospective customer's details. Business workflows have been implemented with the appropriate GUIs to do this.

In order to meet the customer request, the sales representative checks the VISP cluster Service Knowledge Base (SKB) for possible solutions and combinations of services. The SKB contains technical information about the services in the cluster and workflows have been developed to add, delete or modify a service as well as to browse the SKB. The Market Directory can also be searched to ascertain which partners are offering which services and the availability of these services. Once the component services required to support the VoIP service for the customer have been selected, the sales representative groups the services provided by cluster partners into a candidate service set. A service set is the result of the composition of the services into one group and enables the selection and combination of services, characteristics and values to be validated. The sales representative stores the definition of the service set in a personal Service Set Catalogue and validates it.

The sales representative uses the VISP workflows to instantiate the service set. Instantiation is a means of reserving resources so that if the customer accepts the offer, the service can be provided to the customer. Instantiation is therefore based on the confirmation of resource reservations from partners contributing services to the service set.

If a cluster partner is not able to provide a service of the service set, an appropriate cluster member is selected by means of trading mechanisms performed according to a particular economic model. Trading is thus part of the service instantiation process and has a business (quote, contract) as well as a technical (instantiation) result. Details of the instantiated service set are stored in the Service Instance Base, which stores all trading and deployment information concerning the service instances comprising the service set. The technical part of the offer can be transferred to an ERP for a full offer preparation, if applicable. This can include all contractual terms and conditions, billing and payment details and SLA information.

The offer is then made to the customer and further negotiations may ensue. If the offer is accepted, the sales representative starts the commissioning of the service set. Commissioning of the service set has to be performed according to the requirements of the offer and in particular its timing. The resources previously reserved are allocated to the service set and once commissioning has been carried out, the service set can be activated on the date agreed with the customer. Commissioning and activation of the service set are carried out automatically with the technical workflows developed in VISP.

A request for service termination would typically imply three steps, deactivation, decommissioning and deinstantiation of the service instance so that its status becomes 'historic'. Again, the technical workflows in the infrastructure carry this out.

An example of a centralized configuration of the VISP infrastructure for a two partner virtual enterprise mode is depicted in Figure 4. This configuration shows two partners A and B with their sales representatives and administrators. All actors are using partner-specific front ends that are connected to a common GUI server running the user interface to the VISP application that is written in Orbeon, an open source forms solution using XForms and Ajax technology. The Orbeon server can access the VISP repository services running as Web services on the repository server. Depending on the mode of the VISP cluster, either partner-specific repositories and/or global repositories can be queried. Additionally the Orbeon server invokes the business workflows running on an activeBPEL server as Web services.

These workflows invoke ATPs and TTPs running in the same engine via their WSDL interfaces. The last component shown in Figure 4 is the mediation server (MS_1) to the VoIP technical
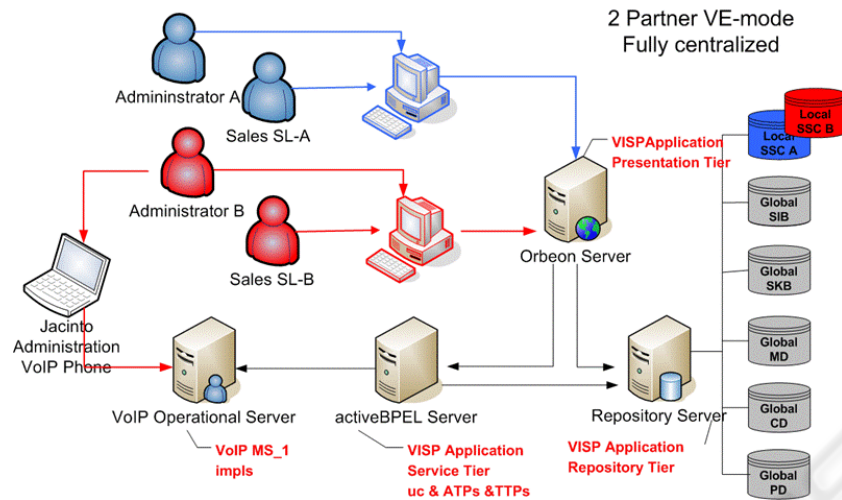
Figure 4: The configuration of the VISP infrastructure.

infrastructure that can be accessed by VISP TTPs and by the ISP network operators via a proprietary administration interface (Jacinto). In operational environments, the repository servers and workflow engines will be replicated and distributed to the organizational domains of the cluster partners.

5 CONCLUSIONS

The research work of the VISP project has investigated the feasibility of using workflow technologies in an e-Business environment of ISPs. This paper has shown how workflows can support e-Business in a virtual cluster of small ISPs collaborating to offer and deliver services to their customers. A platform is being developed within the VISP project to model, specify and execute the business and technical workflows that have been realized. In assessing the research work, the following points can be made.

Experiences from the work in the project show that it is a challenge to extract the knowledge of experts in a form that is amenable to automation. The modeling and specification of textual specifications based on the knowledge of network engineers therefore has to undergo several reiterations.

Also, although there is a standardized mapping from BPMN to BPEL, the fact that BPMN is a graph-oriented language and BPEL a block-structured language has meant that conventions had to be established that were based on experience within the project as well as on work undertaken elsewhere (Ouyang, 2008). When using Web service technology it was also found necessary to agree on

common conventions to ensure their interoperability and reusability. This comprises agreements on namespaces, message definitions, and binding styles. The WS-I Basic Profile was therefore adopted throughout the project (WSIO, 2004).

A big challenge in VISP is to interface generic business processes with dynamic technical processes. During the design time of the VISP application it is known that for each ISP service, corresponding ATPs with specific WSDLs have to be invoked. Unfortunately these WSDLs are unknown during design time. Thus a dynamic invocation mechanism has been developed that generates corresponding SOAP messages from information stored in the VISP repositories using XSLT transformations and retrieving endpoint addresses from the VISP UDDI. Such a dynamic invocation concept can be reused in every dynamic SOA environment.

The work in the VISP project is ongoing. Additional ISP services are being made available for offer and the trading models used are to be extended. More work is also required on ERP integration via OAGIS 9.x WSDL interfaces, and the configuration of the software needs to be based on a distributed architecture to replace the centralized one currently adopted.

Workflows are an interesting and innovative technology for supporting e-Business in the ISP domain and the marketing and provisioning of ISP services. Such technologies are being used increasingly for both intra- and inter-enterprise cooperation and ISPs, with their knowledge of Internet and Web technologies, are well-placed to use these technologies themselves. The research and development work within the VISP project has shown has shown that an infrastructure based on

workflow technology is feasible and can provide an effective automated environment allowing small ISPs to cooperate in offering and delivering services to customers. In addition, several technical solutions developed in the project can be transferred to SOA implementations in different application domains.

Despite the challenges encountered in implementing the workflow technologies for VISP objectives, an analysis of the project results to date show that workflow technologies have potential and can be used to support a virtual cluster of small ISPs. The VISP application is therefore being prototyped and will be further developed for use in a commercial environment.

ACKNOWLEDGEMENTS

REFERENCES

Andrews, T., et al., 2003. *Business Process Execution Language for Web Services*, version 1.1, http://download.boulder.ibm.com/ibmdl/pub/software/dw/specs/ws-bpel/ws-bpel.pdf.

BPEL, 2007. *Web Services Business Process Execution Language*, version 2.0, http://docs.oasis-open.org/wsbpel/2.0/OS/wsbpel-v2.0-OS.html.

BPMN, 2006. *Business Process Modeling Notation (BPMN) Specification*, OMG Document dtc/06-02-01, Final Adopted Specification.

BPMN, 2008. *Business Process Modeling Notation (BPMN) Specification 2.0*, OMG Document bmi/2008-02-06, Initial submission.

Camarinha, L.M., Silveri, I., Afsarmanesh, H., Oliveira, A.I., 2005. "Towards a Framework for Creation of Dynamic Virtual Organizations". In *Collaborative Networks and Their Breeding Environments (PRO-VE'05), 26-28 September 2005, Valencia, Spain,* ed. L.M. Camarinha-Matos, H. Afsarmanesh and A. Ortiz, Springer Science+Business Media, New York, pp.69-80.

Camarinha-Matos, L.M., Afsarmanesh, H., 2006. "Collaborative Networks: Value creation in a knowledge society". In *Proceedings of PROLAMAT'06, Shanghai, China, 14-16 June 2006*, Springer, New York.

Cockburn, A., 2001. *Writing Effective Use Cases*, Addison-Wesley, Boston, MA.

Eckert, K-P., Glickman, Y., Hall, J., et al., 2006. "Workflow Technologies for a Virtual ISP". In *Exploiting the Knowledge Economy: Issues,* *Applications, Case Studies*, P. Cunningham and M. Cunningham, ed. IOS Press, Amsterdam, pp.1631-1638.

Keen, P., McDonald, M., 2000. *The eProcess Edge: Creating Customer Value and Business Wealth in the Internet Era*, Osborne/McGraw-Hill, Berkeley, CA.

Kürümlüoglu, M., Nøstdal, R., Karvonen, I., 2005, "Base Concepts". In *Virtual Organizations: Systems and Practices*, ed. L.M. Camarinha-Matos, H. Afsarmanesh andM. Ollus, Springer Science+Business Media, New York, pp.11-28.

OAGIS (Open Application Group Integration Specification), 2008. Business Object Documents, http://www.oagi.org/downloads/oagis/oagis92_registration.htm.

Ouyang, C., Dumas, M., ter Hofstede, A.H.M., van der Aalst, W.M.P., 2008. "Pattern-based Translation of BPMN Process Models to BPEL Web Services", *International Journal of Web Services Research*, 5(1), pp.42-62.

van der Aalst, W.M.P., ter Hofstede, A.H.M., Weske, M., 2003. "Business Process Management: A Survey". In *Business Process Management International Conference, BPM 2003, Eindhoven, The Netherlands, June 26-27, 2003, Proceedings*, ed. W.M.P. van der Aalst, A.H.M. ter Hofstede, and M. Weske, LNCS 2678, pp.1-12, Springer-Verlag, Berlin.

Wohed, P., van der Aalst, W.M.P., Dumas, M, ter Hofstede, A.H.M., 2003, "Analysis of Web Services Composition Languages: The Case of BPEL4WS". In *Conceptual Modeling – ER 2003. 22nd International Conference on Conceptual Modleing, Chicage, IL, USA, October 13-16, 2003, Proceedings*, ed. I-Y Song, S.W. Liddle, T.W. Ling and P Scheuermann, LNCS 2813, Springer-Verlag, Berlin, pp.200-215.

Wohed, P., van der Aalst, W.M.P., Dumas, M, ter Hofstede, A.H.M., Russell, N., 2006, "On the Suitability of BPMN for Business Process Modelling". In *4th International Conference on Business Process Management (BPM 2006),5-7 September 2006, Vienna, Austria,* ed. S. Dustdar, J.L. Faideiro and A. Sheth, LNCS 4102, Springer-Verlag, Berlin, pp.161-176.

Workflow Management Coalition, 1999. *Terminology & Glossary*, Document WFMC-TC-1011, Issue 3.0, http://www.wfmc.org/standards/docs/TC-1011_term_glossary_v3.pdf.

WSIO, 2004. Web Services Interoperability Organization, *Basic Profile Version 1.0*, http://www.ws-i.org/Profiles/BasicProfile-1.0-2004-04-16.html#R2110.