SPIKE[1] – A Collaboration Platform for Short-Term Virtual Business Alliances

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Abstract. More and more companies are realising that business is best carried out in project-based virtual alliances and are intensively networking and collaborating with partner companies. This requires convergent, adaptive, and interoperable IT environments ready to support flexible, loosely coupled networked enterprises, anywhere, anytime - regardless of heterogeneous systems and applications in use. This paper presents the basic idea and vision as well as the major technical building blocks of the SPIKE collaboration platform. The solution encompasses a semantically enriched service oriented infrastructure employing an enterprise service bus. At the user interface level, we follow a collaborative process portal approach, capturing the user's working context and seamlessly transmitting it to other applications and services according to the current workflow. Special focus lies on the security issues involved including a federated identity management (IdM) infrastructure, guaranteeing secure and coordinated interactions between and across companies' borders.

Keywords: business network, collaboration, networked enterprise, virtual alliance

1 Introduction

Globalisation, shorter innovation cycles, and increased competition are big challenges today's organisations face. Additionally the unstable situation of the economy in consequence of the current financial crises forces organisations to rethink their ways of doing business in order to stay successful and achieve sustainable competitiveness. Breaking up entrenched business structures to enable flexible project structures and performing business through collaborative value chains across companies' borders with anybody, anywhere, anytime regardless of underlying information technology infrastructures and business processes represents a promising way [1]. Actual surveys by [2] and [3] back this trend and predict a significant increase of collaborations in the forthcoming years.

[1] http://www.spike-project.eu

In most economies, small and medium-sized enterprises (SME) represent the biggest fraction of companies. For instance, in the European Union, SMEs comprise 99% of all companies [4]. For them flexible collaboration with partners is of particular interest because today the key to economic success is flexible and fast reaction to market opportunities which still is limited by organisations' cumbersome business structures.

Seamless interoperation with other companies to enable the integration of different capabilities holds huge potential to counter existing challenges. Thereby, information and communication technologies have been identified as critical success factors (e.g. by [5] and [6)] for efficiently running virtual alliances. However, current available collaboration technologies still lack concepts like powerful integration of heterogeneous environments across the partner sites, support of interoperable business process management, the potential to execute inter- and intra-domain workflows, security and trust of the collaboration platform, and a proper user- and access rights management across different domains. To tackle and overcome those deficiencies is the main goal of the SPIKE project.Please note that literature provides different terms such as networked enterprise, virtual organisation, or virtual enterprise representing the concept of virtual alliances (e.g. [4], [5], and [6]). For simplification reasons we will use these terms synonymously throughout this paper.

This paper presents the vision of the SPIKE collaboration platform and derives the main technical building blocks. The remainder of the paper is outlined as follows: In section 2 we present the vision of our SPIKE project. Subsequently the technical building blocks of the SPIKE platform are presented subdivided in basic and collaboration-specific components and are further laid out in section 3 and section 4. Finally, section 5 concludes this paper and gives an outlook on current and future work.

2 SPIKE Vision

The goal of the SPIKE (Secure Process-oriented Integrative Service Infrastructure for Networked Enterprises) project is to research and develop a software platform for the easy and fast setup of short-term (< 6 months), project-based and loosely coupled business alliances. Please keep in mind that SPIKE does not consider contractual issues but presumes that all organisational and legal prerequisites are negotiated outside the platform. The SPIKE platform rather gets involved if these issues are solved among the foreseen alliance partners. "Loosely coupled" in the SPIKE context means, that there is no need for further pre-established technical or organisational relationships between the prospective partnering organisations. SPIKE basically targets two main organisational objectives:

- Outsourcing parts of the value chain to business partners (and vice versa, offering such parts in form of services)
- Enabling collaboration between members of participating organisations through ad-hoc created as well as predefined business processes.

In fact the SPIKE platform especially focuses on enabling even previously unacquainted companies, be it powerful, global companies or highly specialised, regionally positioned SMEs to set up and run short-term, target-oriented collaborative projects and thus to bring flexibility to collaborations between networked enterprises. The SPIKE vision is best characterised by a 3-layered architecture of a business alliance (see **Fig. 1**).

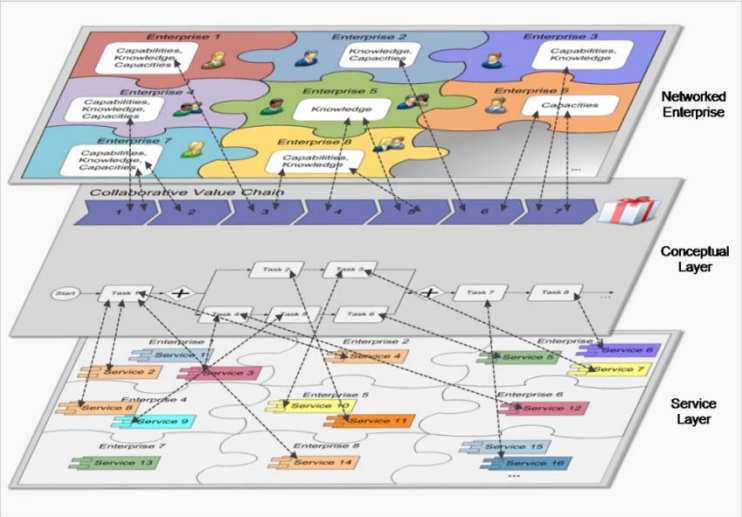

Fig. 1. Architecture of a SPIKE Virtual Business Alliance

On the *Networked Enterprise layer* different companies exhibit and provide their particular knowledge, expertise, capabilities, capacities, and resources. However, for more complex and sophisticated problems, competencies of a single company may not suffice to succeed in solving a given problem. It may be necessary to outsource parts of the value chain to business partners. Therefore, companies of different sizes from diverse sectors, specialised in varying areas join forces and build virtual business alliances. To be able to collaborate with others, these companies have to exhibit a given degree of maturity, which characterises them as networked enterprises. Within these virtual business alliances, every involved company carries out the tasks it is specialised in. Additionally, by collaborating with companies, all involved participants may gain new business opportunities with previously inaccessible customers and partner organisations.

The second layer, the *SPIKE Conceptual Layer*, is the conceptualisation of the business alliance and its goals. Usually, a collaborative project starts with a common goal of all alliance partners, only accomplishable by joining forces. To reach that goal, a high-level strategy has to be agreed upon by all involved parties, which in later steps is further refined into a detailed business process specification. In the SPIKE context, the business process specification is done via Business Process Modelling Notation (BPMN) [7]. The modelling of the collaboration project's workflow on an

abstract level is done outside the SPIKE platform employing existing tools such as Eclipse BPMN Modeler, Adonis or Visual Paradigm. All these BPMN tools allow transforming the graphical BPMN model to a Business Process Execution Language (BPEL) process which is then input to the SPIKE platform. On an abstract level means that the service providers that are responsible for carrying out given tasks in the workflow are not yet assigned in the BPMN model but dynamically assigned by the SPIKE platform at runtime of the resulting BPEL process. Within the SPIKE portal (see section 4.2), the BPEL representation of the collaboration project's workflow is then further refined, the actual service providers that support a given task in the workflow are statically assigned or, what is a far more interesting capability of the SPIKE platform, can be specified via required and semantically specified capabilities and goals. This allows for dynamic selection of the actual service instance at runtime of the workflow, considering different specified criteria such as availability or costs per service request.

The *SPIKE Service Layer* consists of mapping instruments to assign proper service instances to business process tasks as outlined above. It therefore supports the specification of service criteria for service instance selection as well as static service assignment. The term *service* in the SPIKE context not only refers to SOAP-based web services, but also to any kind of service, be it an automated, electronically available service or a manual task which in the end just returns an electronic result e.g. in form of a document or an status update in the workflow. The SPIKE Service Layer particularly supports retrieving, selecting, orchestrating, managing, and executing all kinds of services in a controlled way. It furthermore provides the technical basis for (semantic) composition of processes, services and applications to integrated workflows. All in all this layer aims at achieving interoperability and integration between organisations and all kinds of services on a technical level to support the spontaneous evolution of business relationships in a flexible and easy to manage manner.

In summary, SPIKE concentrates on the Conceptual Layer and the Service Layer, which are both supported by the SPIKE platform. In particular, they are supported by the major technical building blocks such as a service specification and enactment infrastructure, ontologies and semantic services, interfaces to business process modelling and a workflow management system, a security sub-system, the identity management infrastructure and a SPIKE portal engine. As SPIKE especially targets short-term project-based collaborations even between companies acting as competitors in other projects at the same time, security of communication as well as confidentiality of sensitive business data (inputs to and outputs of the collaboration) is a major concern. A federated identity management infrastructure is of particular importance as it forms the technical basis that primarily enables to easily delegate and integrate personnel into collaborations and provide them with appropriate privileges.

3 Basic Technical Building Blocks

In order to meet the ambitious goals of the SPIKE system the project is divided into several technical building blocks. These may either be blocks delivering basic

technologies or blocks offering extended technologies to support collaborations. Please note that although we use the term "basic" this should not be interpreted as simple but as fundamental services other building blocks rely on for further refinement. In the following we describe the major basic blocks while in section 4 the major collaboration-specific ones will be explained.

3.1 Business Process and Workflow Management

The starting point of any collaboration via SPIKE is a business process model (see Conceptual Layer of **Fig. 1**). In general, the workflow arising from this model is the automation of a business process, in whole or partly, during which documents, information or tasks are passed from one participant to another, according to a set of procedural rules [8]. The services being invoked might be carried out fully automated, manually by a person or by any mixture of these two possibilities. For SPIKE's BPM component it is vital to develop mechanisms for flexible mapping of choreographies and orchestrations to services. In order to overcome the insufficient degree of machine-processable knowledge about processes, a combination of semantic Web services and business process management as e.g. proposed by [9] is employed. Further development for semantic description matching, message transformation and processing during run-time (see section 4.3) for both, process fragments and processes composed of them, is necessary. SPIKE's BPM component focuses on the management of inter-organisational collaborative business processes which can suffer from consistency issues when composing process fragments from different parties. SPIKE's semantic BPM engine handles customised reference processes. These are ad-hoc defined workflows and distributed processes built from generic process fragments. BPEL processes as possible inputs to SPIKE's BPM component define their interactions with the "out of process" world through partner links. Partner links are typically static (selected by developers at design time), whereas dynamic binding of partner links is also possible and supported by the SPIKE project.

3.2 Semantic Modelling

A workflow is the basic entity for collaborations in SPIKE. It is vital to the platform's flexibility, that these workflows can be easily defined as generic as possible. Current workflow management techniques and business process languages (see section 3.1) however, enable only a static definition of the orchestration of business processes and their respective execution, without allowing any software technology to automatically combine existing services to form new services with new, dynamically defined functionalities. Services described by traditional technologies like WSDL do not offer this possibility because a textual description of their capabilities is not machine-readable. Adding semantic information to service descriptions alleviates this task by creating the possibility of intelligent agent applications (so-called semantic business process engines) that use a structured representation of the services' properties for service composition. Many different concepts for semantic annotations exist such as WSMO, WSDL-S and OWL-S, but none of them is mature enough to work out of the box. SPIKE is therefore expected to

make significant contributions to these technologies after a careful assessment of their respective strengths and weaknesses.

3.3 Security Layer

The SPIKE Security layer provides basic security services all across the SPIKE platform to maintain the goals integrity, confidentiality, non-repudiation, availability, and authentication. Additionally, advanced security services such as authorisation, access control, or privacy/anonymity will be provided by the SPIKE Security Layer. An easy-to-administer security infrastructure based on portlet technology as outlined in section 4.2 is currently being developed. The security infrastructure has to support large virtual organisations comprising various collaborating partners. The security of sensitive business data is also endangered by the flow of context and message data between organisations. Thus, also a message and context filtering capability dealing with this issue is researched upon. Different approaches towards access control such as Role Based Access Control (RBAC) and Attribute Based Access Control (ABAC) exist. Currently we are aiming to apply ABAC by enhancing the concept to use the context information passed on in SPIKE's bus concept and the semantics of attributes.

4 Collaboration-Specific Technical Building Blocks

In this section we describe technical building blocks which make use of the fundamental functionality offered by the basic building blocks. We call them "collaboration-specific" because they are specific to support the vision of SPIKE.

4.1 Federated Identity Management

The emerging demand for sharing identity information between organisations results in greater need for standardised channels to exchange user-specific data and credentials. This is also necessary to reach the desired target of propagating only those rights to individual users and systems that are necessary in the user's role. The secure and efficient administration of numerous personal attributes is one of the key requirements on SPIKE's agenda. Another issue tackled by SPIKE is enforcing a strict and controlled synchronisation of identity information among the individual partners' user repositories within collaborations. Going beyond the current state of development and targeting the issues outlined above, SPIKE strives to develop a web-enabled service for management of customer and employee identities both powerful and generic enough to be ready for use in every possible business alliance adhering to the following guidelines:

- Enable privacy-compliant mapping between individual identity realms
- Allow for distributed, secure, and purpose-constrained storage of identity-related information
- Enable inference and management of identity attributes for use in access and authorisation use cases
- Create reference models for federating identities in business alliances

In order to share identity information with external sources, SPIKE employs standards such as SAML, SPML and XACML. The SPIKE federated IdM infrastructure will strongly interface with the IdM system of the users' home companies, the SPIKE portal and the Service Bus.

4.2 Portal Technology, Inter-Portlet Communication and Context

According to [10], a portal is characterized as "a doorway to the cyber world of information". Technically, a portal combines multiple web applications (as so-called portlets) to one single portal webpage. Going beyond the definition given above, SPIKE's portal server extension is used for semantic context capturing and communication among individual applications connected via the SPIKE platform. In contrast to existing integration platforms, however, SPIKE aims at providing a generic, context-based portlet integration method by capturing the user's context and annotating the portlet's mark-up using semantic web technologies. Going beyond existing solutions which do not consider the semantics of the inter-portlet communication, SPIKE binds the context of a SPIKE-compatible application to a workflow instance, instead of only to user-sessions, meaning that context-aware collaboration between multiple parties is enhanced using SPIKE. The SPIKE portal distinguishes between core portal functionality and its external interfaces offering the possibility to integrate external applications. Doing so, the SPIKE portal instance is strongly aligned with its service bus system management layer, establishing data connections to outside applications. This assures inter-portlet communication as well as capturing and transferring the user's context as outlined before. It is the SPIKE Service Bus' task to accept semantically annotated information and provide it to all parties involved in the right manner and at the right time.

4.3 SPIKE Service Bus

The SPIKE platform is built upon the concept of a service-oriented architecture, applying an Enterprise Service Bus as a common communication and integration infrastructure. According to [11], "an ESB is not an academic exercise; it was born out of necessity". The problem, however, today still is finding the best matching service for a particular requirement, especially when considering context aspects. Future ESB solutions like the one the SPIKE project is demanding, therefore have to have extended semantic functionality [9] to achieve the two main objectives: automated selection of the most suitable service for the next task in the workflow and automated, possibly semantically supported transformation of service messages in order to achieve interoperability between heterogeneous domains as well as being able to integrate modern business applications with legacy systems [12]. The SPIKE Service Bus therefore is strongly connected to the workflow engine, which manages the overall process and service orchestration and the semantic components for reasoning and transformation. Furthermore it relies on the security and identity management infrastructure, especially for transparent user authentication and authorisation towards external services.

5 Conclusion, Current and Future Work

This paper presents the key ideas and vision of the SPIKE collaboration platform as well as its basic and collaboration-specific technical building blocks. As of writing this paper, the requirements of the SPIKE platform have been collected and the overall architecture and functional specification of the major components were delivered. Special focus will be put on evaluating existing security infrastructures and identity management solutions and adopting these to the particular needs arising within a platform for short-term business collaborations. Additionally we assess the potential of semantically annotated business process models in combination with automatic service discovery and binding. The SPIKE Service Bus therefore provides a common communication infrastructure and the graphical user interface will be supplied by the SPIKE portal. To reach these targets, we work in strong cooperation with user partners from the consortium but also external to the project, giving the intended audience the possibility to actively get involved in the project as well as to provide the SPIKE development team with further details about their individual demands.

Acknowledgement

The research leading to these results is receiving funding from the European Community's Seventh Framework Programme under grant agreement no. 217098. The content of this publication is the sole responsibility of the authors and in no way represents the view of the European Commission or its services.

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