Data & Knowledge Engineering 91 (2014) 52–89

Contents lists available at ScienceDirect

Data & Knowledge Engineering

journal homepage: www.elsevier.com/locate/datak

Editorial

A reference architecture for managing dynamic inter-organizational business processes

Alex Norta [a], Paul Grefen [b], Nanjangud C. Narendra [c]

[a] Tallinn University of Technology, Department of Informatics, Akadeemia Tee 15A, EE-12616, Tallinn, Estonia
[b] Eindhoven University of Technology, Faculty of Technology and Management, Department of Information Systems, P.O. Box 513, NL-5600 MB, Eindhoven, The Netherlands
[c] Cognizant Technology Solutions, Bangalore, India

ARTICLE INFO

Article history:
Received 13 September 2011
Received in revised form 1 April 2014
Accepted 4 April 2014
Available online 25 April 2014

Keywords:
eSourcing
Inter-organizational
Reference architecture
Business process
Ecosystems
Cross-enterprise

ABSTRACT

For improving the efficiency and effectiveness of business collaboration, the need emerges to inter-organizationally match e-business services. Recent research activities show heightened attention into that direction with the ecosystems-emergence of service-oriented computing clouds. As this increases the business-, conceptual-, and technical governance complexity, a need exists for using a reference architecture to evaluate and design standard-, and concrete architectures for business-to-business (B2B) collaboration. In this paper, we fill that gap by presenting the eSourcing Reference Architecture eSRA that emerges from B2B-research projects and we check this with a scenario-based validation method. We demonstrate how eSRA enables a quick evaluation of not only research-based B2B-architectures but also of industry application suits. That way, we show the usability and applicability in that with the help of eSRA, system designers directly establish a comprehensive understanding of fundamental B2B concepts and develop higher-quality domain-specific architectures.

1. Introduction

Companies envision that inter-organizationally connecting their business processes allows them to transact in a faster and more cost-effective way with better quality of service. We define an inter-organizational business process as a B2B-composed flow of related activities that together create a customer value. This must happen in a dynamic way in that they are formed by the automatic integration of the sub-processes of the involved organizations. Thus, dynamic means that during the setup phase, collaborating organizations find each other by searching business-process marketplaces and match externally contractual-sphere processes of larger in-house processes.

Such collaboration between manufacturing companies in the B2B-domain is complex from a business, conceptual, and technological point of view. A need exists to develop business-collaboration systems according to a uniform vocabulary and template set of guidelines for achieving meaningfully automated business-interoperability for which a reference architecture serves as a suitable artifact. We define a reference architecture [31] as a template solution for an architecture of a particular domain such as service-driven enterprise architecture where the structures and respective elements and relations provide templates for standard-, or concrete architectures.

Recent research publications with relevant standard architectures exist, most notably the CrossWork architecture [49] and also further scientific proposals of business-collaboration architectures [27,62,67,106]. The main feature of a reference architecture is the design in a top-down fashion while standard architectures evolve in a bottom-up way abstracting from concrete architectures. Yet, a

E-mail addresses: alex.norta@gmail.com (A. Norta), p.w.p.j.grefen@tue.nl (P. Grefen), ncnaren@gmail.com (N.C. Narendra).

http://dx.doi.org/10.1016/j.datak.2014.04.001
0169-023X/

standard architecture should be reference-architecture adhering. Similarly, concrete architectures for application systems facilitate the automation of inter-organizational business processes to different degrees. The most notable examples are SAPs Sourcing [95], ORACLEs Sourcing [83] application suits, or the Sourcing platform [56] from IASTA.

While these bottom-up emerged architectures above focus on specific aspects of inter-organizational business processes, they cannot serve as general guiding architectures. This paper fills the gap by investigating the following research question: how does one equip system designers with the means to rapidly establish a comprehension of the suitability, completeness and quality of inter-organizational business-process architectures and their application instantiations? To answer this question, we employ a required top-down development approach by choosing the suitable *eSourcing* concept [75,76] that results from studying best practices of B2B with the CrossWork industry partners from the automotive industry. eSourcing is a framework for harmonizing on an external layer the intra-organizational business processes of a service consuming and one or many service providing organizations into a B2B supply-chain collaboration. Important elements of eSourcing are the support of different visibility layers of corporate process views for the collaborating counterpart and flexible mechanisms for service monitoring and information exchange.

The recognized notion of process views is essential to support sourcing [40,69] and the eSourcing concept is to the best of our knowledge the only one for supporting a consumer organization to find and connect to a service provider. Other approaches address the construction of process views [37,44], which is not specific to sourcing [51]. Most importantly, while the eSourcing concept enables diverse ways of process-view creation and matching, other approaches support only one way. Yet another class of approaches considers the problem of matching process descriptions of services [45,59,75] but does not relate this to the problem of projecting internal processes to process views. eSourcing is technology independent but feasible to realize with means of service-oriented cloud computing [103,107], the latter facilitating the creation of complex cloud-ecosystems. Ecosystems have business dimensions of varying semantics and ontologies, social dimension for different stakeholders, and architectural dimensions for platform engineering [39]. The adoption of a decentralized software ecosystem results in intra-organizational processes to behave in a dependable way [18] on a composed inter-organizational layer. Architectures are pivotal in that case for guiding the coordination-design across organizational system boundaries. As the interfaces of service-ecosystems affect coordination soundness, introducing new functionality triggers a reconciliation of the interface specifications [19,24]. Also [104] explains that an ecosystem of services and participants requires a governance structure for management of engaging in a partnership based on contracts as a commitment between legal entities.

The eSourcing Reference Architecture eSRA specifies the governance structure to facilitate the development of high quality ecosystems with means of service-oriented cloud computing. eSRA supports the instant understanding and communication between architecture designers of such ecosystems and is guiding for a fast evaluation of existing architectures. eSRA serves as a guiding reference architecture for the design of application systems with fundamental design principles and specifies high-quality functionalities for rapid application development. For this reason, we define a reference architecture [88] as a division of functionality with exchanged data flow mapped onto software elements that together implement the required functionality for a specific context and the business goals of the stakeholders. The method for designing eSRA is coherent and systematic in that it combines existing best practices from scenario-based evaluation methods [12], business-collaboration models [75,76], architecture styles [26,63,96] and design patterns [48].

The structure of this paper is as follows. First, Section 2 presents the conceptual context of inter-organizational business with a three-layer framework populated by a formal collaboration model. With that conceptual foundation, Section 3 infers a collaboration lifecycle from which we deduce a set of functional requirements. Furthermore, in accordance with literature studies, Section 3 also defines non-functional architecture requirements specified in accordance with the conceptual context and ends with a discussion about what scenario-based evaluation method to choose for eSRA. Next, Section 4 shows the scenario-method evaluated eSRA specification on three refinement levels that takes into account the conceptual business collaboration context and the sets of functional and non-functional requirements. The presentation of eSRA we textually present in a way that shows the implementation feasibility, i.e., the text comprises implementation suggestions, or pre-existing services that are candidates for an eSRA-implementation with means of Service-Oriented Cloud Computing (SOCC), or other concrete pre-existing technology. Section 5 gives the results of a second evaluation step for the reference architecture where we separately check eSRA-adherence to all functional- and non-functional requirements. This incorporates comparisons with existing architectures for business collaboration from research and industry. Finally, Section 6 presents related work and Section 7 gives conclusions and future work. The appendices show results of the ATAM-evaluation and subsequently conducted control-survey.

2. Features of inter-organizational business processes

The prerequisite for reference-architecture development is the study of best practice in industrial reality. For that purpose, we employ the CrossWork [70] case study stemming from a leading truck producer and suppliers from a cluster of small enterprises. A project objective is the sound formalization of inter-organizational business processes [76] to allow for feasible realization with SOCC. For reaching the latter target, a gap exists that eSRA fills. Thus, for reference-architecture development, this section deduces a set of functional- and non-functional requirements from the formalized collaboration model. Based on case studies conducted with industry partners in the CrossWork project [49], Section 2.1 explains the conceptual business-collaboration setting. Finally, Section 2.2 discusses a refined collaboration model within that framework.