A collaborative and user-adaptive architecture enabling seamless cross-domain e-commerce transactions

Till Janner, Christoph Schroth
SAP Research CEC St. Gallen and
University of St. Gallen, Institute of
Media and Communication Management
St. Gallen, Switzerland
{till.janner, christoph.schroth}@{sap.com | unisg.ch}

Abstract

During the last years, e-Business has become widely accepted in all different industry segments. By adopting systems that allow for business transactions to be conducted electronically rather than paper-based, users can significantly reduce the effort for data-processing, increase business data accuracy and may even discover new business models or partners.

However, the penetration of such systems is still remarkably low especially among small and medium size enterprises (SMEs) and very small enterprises (VSEs). Often, they do neither have the capacity to build tailored solutions allowing for conducting business with their partners over the web nor the necessary capabilities. Also, existing standards and solutions mostly do not adequately support flexible, cross-domain collaboration. Mostly, they do not account for changing user needs and only provide industry-specific protocols and data formats.

In the frame of the EU-funded GENESIS project, we develop a novel e-Business framework that enables SMEs and VSEs (in the following referred to as users) to perform business transactions over the web, by interconnecting their individual, existing software applications with those of the collaborating parties. Thereby, we focus on seamless, cross-domain interoperability and adaptivity to changing user needs in order to facilitate the adoption of e-Business solutions.

1 Introduction

During the last decade, there has been a significant increase of utilization of e-Business worldwide. Especially in the case of small and medium (SMEs) or very small enterprises (VSEs), however, the penetration of such technologies is very limited.

Among those users, many different proprietary software applications are in place that are used for conducting their every-day business processes. As surveys show, a significant proportion of these small businesses even solely leverage paper-based approaches and do not use any enterprise software systems at all. As a consequence of this situation, severe errors may occur during business transactions, actually simple and unvarying processes require lots of manual input, thereby preventing from seamless, cross-industry and cross-border interoperability.

This, in turn, results in unnecessarily high costs and missed business opportunities. In this work, we propose a holistic, novel framework for performing e-Business that is adaptive to possibly changing, individual user needs. Electronic, seamless collaboration is achieved by allowing for different and even changing business process and document standards. Users will be able to simply plug (with the help of software adapters) their existing legacy systems into the envisioned platform.

The paper is structured as follows: First, we outline the major challenges SMEs and VSEs are facing when trying to adopt systems enabling them to conduct their business over the web. Second, we present the EU-funded project GENESIS, which provides the frame for this work. In Chapter 2, we describe the requirements a novel, international framework for e-Business must fulfill to emerge as a prevailing standard. Adaptivity to changing legal requirements and individual business needs and the provision for true, seamless interoperability are two of the major requirements. Chapter 3 proposes the novel framework and describes the methodologies for modeling users and their requirements with regard to business processes and documents in detail. Technical standards that are leveraged for the implementation of a platform are presented as well. Chapter 4 illustrates some relevant, international projects that also deal with new e-Business solutions and account for individual user preferences and intend to promote new standards. Chapter 5 gives a short summary of the results of our work.

1.1 Challenges SMEs are facing with regard to the adoption of e-Business

The high initial costs for designing and deploying e-Business solutions has been identified as a first, major hurdle preventing especially SMEs and VSEs from adopting such technologies. The high cost of ownership of the respective systems is a critical, additional factor.

The heterogeneous legal and statutory frameworks represent a further obstacle in particular when it comes to cross-border transactions: The national regulations sometimes vary significantly and add high complexity to designing compliant e-Business systems that provide for efficient interoperability between business partners.

Besides these hurdles, the different user preferences and the proprietary, existing systems (we refer to the SMEs and VSEs as users in the context of this work) must be taken into account when thinking of an integrated framework allowing for electronic interoperability. SMEs usually have specific applications installed already (reaching from large ERP systems to mere spreadsheet

based processes). For small size enterprises, it is thus hard to adopt existing e-Business standards that do not comply with their existing software components: Such businesses usually do not have the financial means to pay for consultants who build and maintain software adapters that interface to existing e-Business platforms.

1.2 The EU-funded GENESIS project

In the frame of the EU-funded GENESIS project [GENESIS, 2006], a consortium of several partners from across Europe tries to tackle all of these challenges and to provide for an affordable, interoperable platform that enables seamless and cross-border collaboration among business partners with specific user needs. In more detail, the major goals include the following points: First, an in-depth analysis of the legal and statutory framework shall be conducted with a clear focus on the new European Union member states in order to identify any potential barriers regarding the realization of e-Business transactions over the Internet. Second, the project partners will perform comprehensive modeling of typical business processes that are run between users and their collaborating entities taking into account country-specific differences. Third, the state-of-the-art in enterprise application interoperability, data modeling and business process interoperability (BPI) is a further major goal. Fourth, the modeling and development of new electronic data formats and messages for the business data representation and interoperation of enterprise applications that are adaptive to diverse and even changing user needs is to be performed. Last, the implementation and testing of the new framework will prove the significant improvements achievable.

In the frame of this project, we examine and model the processes and data elements exchanged by the users mentioned above, but so called Intermediaries (e.g., Banks) and governmental institutions are considered as crucial parts of a comprehensive, new e-Business framework as well.

Project partners include universities, software vendors, governmental institutions and end users (SMEs and VSEs) which will play a major role during the user modeling phase. The focus of the whole project lies on the new EU member states in the eastern parts of Europe where the majority of businesses lie in the area of small and medium enterprises.

2 Requirements for a successful adoption of e-Business technologies among SMEs and VSEs

The low penetration of e-Business technology especially among the abovementioned users is due to the severe challenges these businesses are facing when trying to adopt one of the existing standards. In the following paragraphs, we outline the requirements that a new interoperability must fulfill for a successful adoption by the users.

2.1 Incorporation of individual user needs and proprietary as well as changing standards

First of all, the needs of the diverse users are quite different. The businesses examined are part of different industries and are thus dealing with different products and services. A real cross-domain interoperability platform

will have to cope with this issue. Also, the various users play different and even changing roles: Some of the collaboration partners will act as sellers, some as buyers of goods and some as mere service partners (e.g., governmental bodies such as tax authorities). Incorporating a mechanism that accounts for different and potentially varying roles is one of the major requirements imposed on a successful e-Business framework.

Users also have different IT systems available. These reach from standard ERP solutions over proprietary systems to mere paper-based solutions.

It would be illusory to assume users would be willing to adapt their every day processes and used systems to a
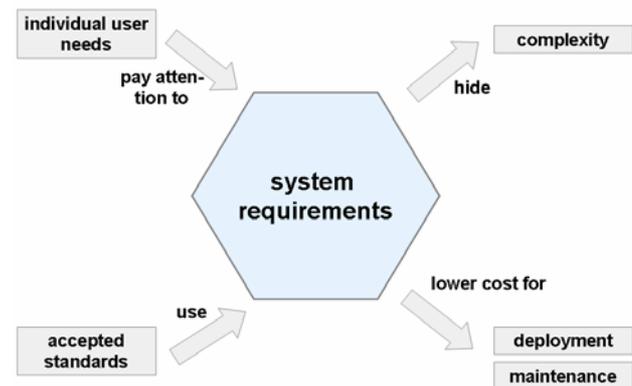

Figure 1-1: Several system requirements

newly available collaboration platform. Instead, our approach will have to allow for incorporating all these individual technical standards and resources to facilitate the adoption of the system by as many users as possible.

As surveys among end users have shown, most business processes that have been investigated and modeled are quite specific and often involve unique process steps. In the frame of our approach, we will have to find methodologies to abstract from the proprietary, so called private business processes to wind up with a more global processs view (later referred to as public process view). This allows for true interoperability despite of actually different individual business processes.

Just like the processes, the format and structure of the pieces of information exchanged between business partners vary considerably depending on factors such as country, industry, the role of the end user and many more. We refer to these exchanged pieces of information as business documents: We define business documents as any documentation that contains information which is relevant either for supporting an activity (e.g. user manual, policies, handbook…) or communicating (e.g letter, email…). They include both electronic and printed documents. One major requirement for the success of our approach will be to find ways to allow for the continued utilization of all theses various existing, different business documents and still ensure an integrated collaboration framework. New ways for data modeling will have to be specified for this purpose.

All the different categories of system requirements (depicted in Figure 1-1) described above also may change over time due to reasons such as varying legal frameworks or changing business needs: The end-user technical infrastructure, the characteristic business processes, the structure of the business documents and roles the users play can vary over time. The framework envisioned in the

case of the GENESIS project has to account for such changes and provide full adaptivity.

Summing up, our envisioned platform must incorporate all different user needs rather than imposing on a common standard that must be adopted by all stakeholders.

2.2 Low costs for deployment and maintenance

As stated in the introductory section, the high cost incurring for building or buying solutions enabling them to conduct e-Business is a huge obstacle for SMEs and VSEs. Software licenses and highly skilled consultants are hardly affordable for these small businesses, not to mention the costs for maintaining and adapting these systems.

We, however, aim at a cost-saving solution that helps reducing effort for performing every day transactions and errors in manual processes, which will be extremely affordable. To make that possible, the following two requirements must be fulfilled: First, the GENESIS architecture and its specifications have to be open source such that no licensing fees are charged to end users. Second, the e-Business framework must be a truly holistic approach, meaning that users are fully enabled to start conducting electronic transactions with their partners after adopting an implementation of our solution. The users considered in our study desire to do one-stop-shopping rather than assembling different modules and standards. By offering one single comprehensive solution, the adoption costs can be reduced to a minimum and the dissemination of the approach is strongly facilitated within the SME and VSE community.

2.3 Hidden complexity

As already stated above, companies in different countries or contexts use different technological standards, business documents and processes. As surveys show, SMEs and VSEs often avoid switching to an electronic implementation of business transactions due to the huge complexity inherent to the realization process. Usually, only sophisticated consultants are able to set up connections between systems that leverage different document standards, message formats and business processes. One major requirement for the acceptance of our platform aiming at cross-domain interoperability and user requirements adaptivity will be to hide the technological complexity from the user. We head for a system where every user simply remains with its proprietary, customized system, while having the chance to communicate and exchange business data with each other business partner who also participates in the envisioned GENESIS platform. In chapter 3, we will propose adequate approaches that work as a solution to this important requirement.

2.4 Widely accepted standard

Before presenting our detailed approach to fulfill all the abovementioned requirements, one last, crucial key to success must be stressed: The approach presented will only provide clear economic benefit to its users if it reaches a critical mass of adopters. Not until a high enough number of SMEs, VSEs, governmental bodies and so called intermediaries commits to participate in the new framework, its full potential can be tapped. A sophisticated dissemination strategy will have to be elaborated to ensure the fulfillment of this last, major requirement.

3 GENESIS - a collaborative architecture enabling seamless cross-border and cross-industry e-Business transactions

Within the Research Project GENESIS, funded by the EU within the sixth framework program, a project consortium of several partners from across Europe is facing the challenges of a collaborative architecture enabling cross-border and cross-industry business transactions.

The following paragraphs present the GENSIS approach how to solve the above-mentioned issues and how to fulfill the requirements. Besides giving an overview of the overall architecture of the system, we focus on dedicated aspects of the chosen approach to emphasize adaptive concepts on two different levels. On the level of the processes and the business data to be exchanged, we describe the semantic aspects of adaptivity. Technical aspects of adaptivity within our approach are covered by a close view on the adapter concepts on how to connect to the GENESIS system.
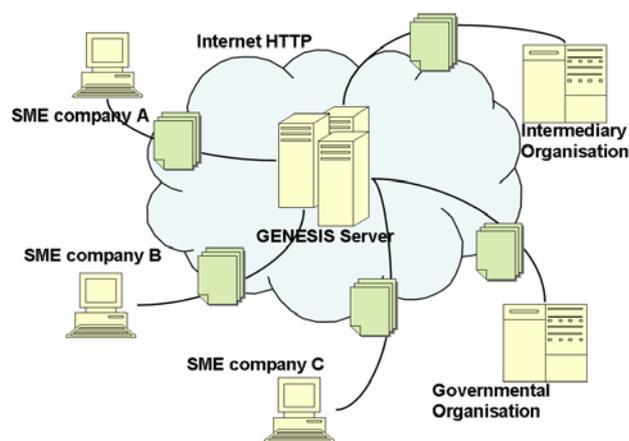

Figure 3-1: GENESIS basic architecture

3.1 Overall system Architecture

As a response to fulfill the requirements described above, the following system architecture will be utilized. Figure 3-1 depicts the overall architecture which can be characterized by the following building blocks:

A central server provides the necessary functionality to connect the users to the system, for managing the process and business data related meta-data and providing a store-and-forward messaging infrastructure. Following the paradigm of a service oriented architecture (SOA) (e.g. as presented in [Alonso et al., 2004], [Papazoglou, 2004]) by the use of state of the art web service technology the required functionality will be provided as a set of web services. The server also contains a registry and repository part, which can be accessed by using the web services to manage the meta-data. Further the server provides capabilities of a messaging infrastructure in form of a store-and forward system. This aspect is of importance due to two reasons. First, it can be assumed that SMEs will not be always connected to the system ("24x7"), and

therefore a store-and forward architecture can assure a message delivery without the need of every user being connected to the system all the time during the conduction of a business transaction. Second, the business documents that contain the data to be exchanged are to be assembled under the responsibility of the user and have to be securely and reliably routed to the receiving party. The technologies planned to use for the implementation of the system lean against Web Service standards and technologies such as WSDL [W3C, 2001] but will also have similarities to the ebXML framework [ebXML, 2006].

The clients of the server can connect to the system in two different ways. A fat client, called adapter, will be implemented on the side of the users to connect existing IT systems to the GENESIS system. This adapter realizes a machine-to-machine interface for an efficient automated transaction processing and to enable an efficient automated the reuse of a users existing IT-infrastructure. In case that users of the system do not have an the ability to develop an adapter, this may be the case for Very Small Enterprises (VSE) who may not use any IT systems, a web-based, thin client will be provided as a machine-to-human interface to access the system.
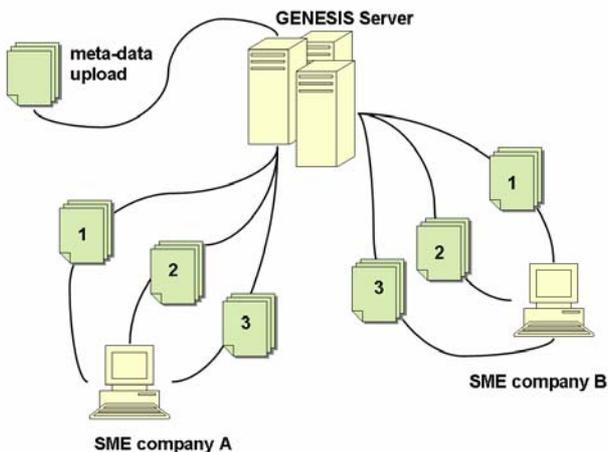

Figure 3-2: Adaptive collaboration among the GENESIS users

The sample scenario in Figure 3-2 depicts the dynamic aspects of the system. In a first step, the process and business data related meta-data have to be uploaded to the repository on the server. The individual users who want to participate at the business processes to conduct their transaction over the system, have to specify a collaboration profile, in which the users provide information on the processes they support specific aspects on how the processes are executed in the business environment (e.g. legal, country or industry specific aspects) and how the business documents have to be specified to be accepted by them. After providing this profile to the servers' registry (1) the prerequisites for conducting business are done. At runtime, the users who are participating at the process to be executed have to negotiate a collaboration agreement where they specify the circumstances under which they will start to conduct their business with each other (2). After that the business documents that are defined to be exchanged during process execution will be sent by means of the store-and forward architecture of the server (3).

3.2 Adaptivity on two levels

Business Process and Data Adaptivity

As the users considered conduct very different kinds of businesses, the related processes and the business documents that are exchanged are not uniform at all. This is due to the fact that users are within completely different contexts (e.g., country, role, industry). Instead of generalizing business processes, which would prevent users from staying with their unique business models, our collaboration framework is able to account for differences regarding processes and the business documents handled.

The UN/CEFACT Modeling Methodology (UMM) [UMM, 2006] is leveraged as a means for specifying collaborative business processes involving information exchange in a technology-neutral, implementation-independent manner. Using the UML language, this standard supports a standardized way to perform business process and information modeling. By means of surveys and user workshops, all the diverse processes are extracted, modeled in a tool [BOC, 2006] that supports the abovementioned standards and then used to create executable business choreographies in the business process language BPEL [OASIS, 2006].

In terms of data modeling, a vast amount of different business documents has to be incorporated by our approach. Depending on country, the related legal framework, the respective industry, and the users` individual preferences, documents vary significantly with regard to overall structure, size, amount of contained data fields, and content of those data fields. Existing e-Business solutions heavily struggle with this huge variety of formats and often only offer very specific, inflexible and industry-specific solutions. RosettaNet [RosettaNet, 2006], for example, provides for an XML- based, comprehensive set of so called Partner Interface Processes (PIPs), which specify the electronic collaboration between business partner both in terms of process flow and the exact structure of the data exchanged. PIPs are divided into seven functional so called clusters such as inventory management, marketing and manufacturing. For each of the clusters, several predefined PIPs can be selected that possibly match the requirements of businesses.

Our adaptive, collaborative framework overcomes this statical approach pursued by RosettaNet: To model the differently structured data used in every-day business by our users, we leverage the novel UN/ CEFACT-based data modeling approach that is based on the so called Core Components [UNCEFACT, 2006]. These describe data objects that can be composed and decomposed according to certain rules and can be used to represent business objects that appear in multiple business domains [Kotok and Webber, 2001]. By applying these syntax-neutral data frameworks, reusability, adaptivity to diverse requirements and a high degree of interoperability among different users can be ensured [Stuhec, 2006]. The following example shall highlight the considerable advantages of this technology: Business addresses show up on most of the business documents investigated in the frame of our work. However, these addresses, again depending on the context in which they are used, vary with regard to their exact structure. A core component could then act as a kind of neutral blueprint that is reused

in the data modeling process every time an address is part of a business document. This avoids that addresses are modeled from scratch each time and thus allows for reuse. In specific, such a core component plays the role of a comprehensive, context-neutral superset of other sub-components that may be part of addresses (e.g., street name, postal code, etc.). In its neutral state, it simply comprises all sub-components that can ever occur in an address used in an arbitrary context. In a second modeling step, depending on the actual context, the appropriate subset is then selected (only the actually relevant parts are used). By using a common library (also referred to as repository) of such reusable core components, the interoperability between business part
ners can be ensured as well. Every user has access to the same semantic base of core components and has thus the same understanding of the data he receives. Figure 3-3
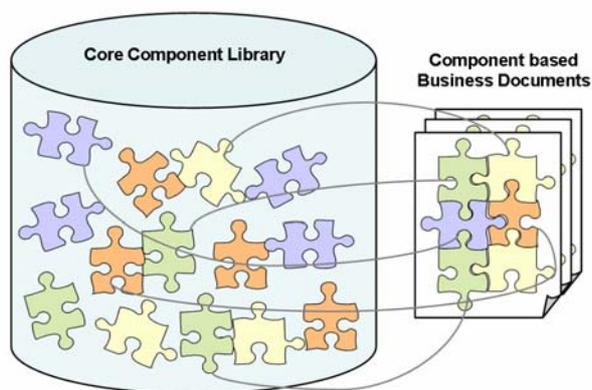

Figure 3-3: Exemplary Use-case for UN/ CEFACT Core Components

depicts the basic principle of the Core Component approach: A common library which is available to all users is used to store the different "blueprint" data objects and to assemble proper business objects out of them. Due to contextualization mechanisms, these blueprints can be adapted to specific user needs, but are still comprehensible to every other user. Because of additional reasoning and semantic retrieval functionality, reuse of these core components is supported as well, leading to a minimum amount of different components needed to model business documents.

Interface Adaptivity

Besides the adaptivity of our framework with regard to different business processes and documents, also the technical adaptivity of the platform to the diverse IT systems of the users must be ensured. This second adaptivity layer allows users to remain with their legacy systems and yet easily connect to the GENESIS platform. As briefly introduced above, two different kinds of technical adapters are envisioned in the frame of the GENESIS project:

First, a so called fat client interconnects the users` Enterprise Application landscape to the GENESIS server through adequate web service [Alonso et al., 2004] interfaces. Using this loose coupling approach, ERP Vendors of the project partners (such as SAP) are developing such connectors for their applications, thereby utilizing a common middleware.

Second, the so called zero client corresponds to the users that need to minimize their overall investment and prefer to access the GENESIS web server through a standard web browser. Of course, users will again pose different and possibly changing requirements to these interfaces, which will be taken into account be utilizing languages such as XSL [XSL, 2006]. Web Interfaces that are based on XML files such as in our case will be adaptable and also changeable with the help of this language.

4 Related Work

Several other initiatives are existing that focus on related topics. They are all well linked to the GENESIS initiative to ensure cooperation and thus foster consistency of the results. For example, in the frame of the EU- funded project INTEROP [INTEROP, 2006], a roadmap for future, European research on interoperability of enterprise applications and software is elaborated. The major goal is to provide a single point of access to all relevant information and applications, functioning as an access to these interoperability communities of interest and practice. The project heads for facilitating the emergence of an interoperability research corpus by integrating the three so called knowledge-components architectures and enabling technologies (to provide for implementation frameworks), enterprise modeling (to identify interoperability requirements) and ontology for setting up interoperability semantics.

The TrustCOM project [TRUSTCOM, 2006] aims at establishing a collaboration framework for e-Business with a clear focus on trust and contract management. The definition and secure execution of collaborative business processes within so called virtual organizations (VO) is in the center of this initiative. The project partners envision these VOs to form on-demand, to act self-managing and share computation and information across enterprise boundaries. The goal is to enable single businesses to collectively offer services to customers that could not be provided by the individual enterprises. These VOs will be based on new forms of collaboration in which participants (enterprises or individuals) can specify and negotiate their proprietary conditions of involvement by means of electronic contracts whose operation is supported and enforced by the computing infrastructure. The TrustCOM project works on defining ways to realize a secure environment for the abovementioned collaborative activities and service where the controls and procedures are automated based on clear specifications of trust, risk and policy.

The European Integrated Project ATHENA [ATHENA, 2006] represents a third related project dealing with the goal to establish a true collaboration between single businesses that are characterized by unique requirements both from the technological and from the business processes perspective: Building upon the ambitious Vision Statement "By 2010, enterprises will be able to seamlessly interoperate with others", the ATHENA project heads for contributing to interoperability by identifying and meeting a number of inter-related business, scientific & technical, and strategic objectives. The development of novel technology components, applications and services, but also the demonstration & testing of the results are in the focus of this project. The project is intended to promote a holistic approach that

enables for mainstream interoperability and has critical mass. ATHENA has been initiating an open, neutral and independent so called Enterprise Interoperability Centre (EIC) to which all stakeholders, in both private and public sectors, are invited to participate. The establishment of the EIC is an action of the European Union's updated eEurope 2005 Action Plan for implementing the Lisbon Strategy.

5 Conclusion

In the frame of this work, we have presented an approach that facilitates the adoption of e-Business especially in the new European Union where SMEs and VSEs are the predominant form of enterprises. The platform we are currently designing and implementing will be adaptive to individual and even changing user needs and ensures seamless and error-free interoperability and thus helps saving costs that currently incur due to transaction errors and the effort required for manual input. As described above, the system also hides complexity, reduces the high, initial costs that usually occur in the frame of setting up e-Business solutions and allows for taking into account changing standards and business rules. The fast dissemination of this framework will help reaching a critical mass.

Acknowledgments

References

[Alonso et al., 2004] Gustavo Alonso, Fabio Casati, H rumi Kuno and Vijay Machiraju. Web Services Concepts, Architectures and Applications. Springer Verlag, 2004

[ATHENA, 2006] Athena European Integrated Project, http://www.athena-ip.org/, last seen in 2006

[BOC, 2006] BOC: ADONIS, http://www.boc-eu.com/index.jsp, last seen in 2006

[ebXML, 2001] The ebXML Technical Specifications, http://www.ebxml.org/specs/index.htm#technical_specifications, last seen in 2006

[eEurope+, 2004] eEurope+ 2003, Progress Report, February 2004, http://www.emcis2004.hu/dokk/binary/30/17/3/eEurope__Final_Progress_Report.pdf , last seen in 2006

[GENESIS, 2006] GENESIS, http://www.genesis-ist.org/english/default.htm, last seen in 2006

[INTEROP, 2006] INTEROP Portal, http://www.interop-noe.org/, last seen in 2006

[Kotok and Webber, 2001] Alan Kotok and David R.R. Webber. ebXML: The new global standard for doing business over the web. *New Riders*, 2001

[OASIS, 2006] OASIS Web Services Business Process Execution Language (WSBPEL) TC, http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsbpel, last seen in 2006

[Papazoglou, 2004] Papazoglou, Mike P.: Service-oriented Computing: Concepts, Characteristics and directions. In: WISE [WIS 2003], S. 3-12

[RosettaNet, 2006] RosettaNet, http://www.rosettanet.org/Rosettanet/Public/PublicHomePage, last seen in 2006

[Stuhec, 2006] Stuhec, Gunther. How to Solve the Business Standards Dilemma - CCTS Key Model Concepts, SAP Developer Network (SDN), https://www.sdn.sap.com/irj/servlet/prt/portal/prtroot/docs/library/uuid/1b873fc3-0901-0010-f7bc-9518e1aed0cf, las seen in 2006

[TRUSTCOM, 2006] TrustCOM, http://www.eu-trustcom.com/, last seen in 2006

[UMM, 2006] The United Nations Centre for Trade Facilitation and Electronic Business: UN/CEFACT Modelling Methodology (UMM), http://www.unece.org/cefact/umm/umm_index.htm, last seen in 2006

[UNCEFACT, 2006] United Nations Centre for Trade Facilitation and Electronic Business, www.unece.org/cefact, last seen in 2006

[W3C, 2001] W3C – World Wide Web Consortium (Hrsg.): Web Service Description Language (WSDL) 1.1. Version 2001. http://www.w3.org/TR/wsdl. W3C - World Wide Web Consortium, las seen in 2006

[WIS, 2003] 4th International Conference on Web Information Systems Engineering (WISE 2003), 10-12 December 2003, Rome, Italy. IEEE Computer Society, 2003

[XSL, 2006] W3C, The Extensible Stylesheet Language Family (XSL), http://www.w3.org/Style/XSL/