

Potential Risks and Benefits of Service-Oriented Collaboration – Basic Considerations and Results from an Empirical Study

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Abstract—Service-oriented Architectures enable companies to cooperate on a completely new level. Although different publications have dealt with the usage of Service-oriented Collaboration in various scenarios, the potential risks and benefits of this collaboration in certain industries have not been observed in detail. In this paper, we present basic considerations about the impact of Service-oriented Collaboration on organizations. Furthermore, we evaluate our assumptions with results from a survey we conducted in the German banking industry. Using data from 52 banks, it turns out that the potential benefits of Service-oriented Collaboration exceed the suspected risks – therefore we deduce that this kind of collaboration is suited to improve the cooperation between and in companies.

Index Terms—Service-oriented Architectures, Service-oriented Collaboration, SOA, IT value creation

I. INTRODUCTION

Due to the standardization of Web service technologies, the Service-oriented Architecture (SOA) paradigm has gained momentum during the last years. The broad utilization of service-oriented technologies creates new opportunities for organizations to cooperate and collaborate, i.e., by establishing new outsourcing strategies.

In this paper, we present potential benefits and risks of Service-oriented Collaboration. Apart from theoretical considerations, we compare our assumptions with the results of a study we conducted in the German banking industry during 2006/07.

The remaining part of this paper is structured as follows. In the next section, basics and common benefits of SOA are presented and Service-oriented Collaboration is introduced. To evaluate our considerations, we use results from an empirical survey we conducted among business/IT architects from Germany's 1001 largest banks (with respect to balance sheet total). The methodology and sample characteristics of this survey are presented in Sect. III. On the basis of the theoretical foundation we identified risks and benefits of Service-oriented Collaboration (Sect. IV). The paper closes with a summary of the findings of this paper and an outlook on our future work.

II. THEORETICAL FOUNDATION

In order to evaluate risks and benefits triggered by Service-oriented Collaboration, it is necessary to define SOA and Service-oriented Collaboration. Hence we introduce the SOA paradigm with regard to collaboration in the following paragraph. Additionally, the second paragraph of this section introduces Service-oriented Collaboration, its potential implementation and utilization. Some related work is presented in the third paragraph.

A. The Service-oriented Architecture paradigm

Even though there is a great difference between the actual implementation of a SOA with a certain technology and the underlying concepts that constitute the SOA paradigm, the term SOA has often been used synonymously with Web service technologies in recent years. As the name “paradigm” implies, SOA is not a technology but a holistic approach to design an enterprise architecture. Using service-oriented concepts, it is possible to model business processes independently from actual technologies or tools [3].

To define the architectural part of SOA, we make use of the following principles [1]:

- All functions (e.g., business functions) are defined as services.
- All services are independent and can be used without paying attention to their actual implementation.
- Services can be accessed by an invocable interface without further knowledge of its location.

Accordingly, a SOA is “an application architecture within which all functions are defined as independent services with well-defined invocable interfaces which can be called in defined sequences to form business processes” [1].

Using this definition, it is possible to apply the SOA paradigm to an application architecture in general or to map exactly one aspect of a company's business model [2]. Business-oriented services may be mapped to (parts of) business processes, thus allowing it to make processes available to new internal and external users, replace business functions, reorganize processes, or build new business functionalities from existing services. SOA enhances the agility and flexibility of companies, making it possible to offer new products and services. As a result, business proc-

esses might have to be adapted in order to tap the whole potential offered by service-oriented technologies [4].

The presented features of SOA lead to new collaboration and cooperation opportunities which will be presented in the next section.

B. Service-oriented Collaboration

Even though several scientific publications have addressed Service-oriented Collaboration (cp. Sect. IIC), there is still a lack of definitions of Service-oriented Collaboration. Hence, we define Service-oriented Collaboration as follows:

Service-oriented Collaboration is the intra- and inter-organizational collaboration based on service-oriented technologies.

Service-oriented technologies can be utilized on different levels of services. Thai et al. define a *SOA Dynamic Collaboration Hierarchy* composed of the following five levels [5]:

- *Protocol interaction* describes the enablement of exchanging information by using a specific protocol like SOAP.
- *Static data interoperability* is the exchange of data based on a predefined format.
- *Static process collaboration* allows the communication between different entities based on predefined interfaces.
- *Dynamic data interoperability* describes ad hoc collaboration between entities based on Service Level Agreements (SLAs), i.e., pre-defined collaboration specifications.
- *Dynamic process collaboration* enhances dynamic data interoperability by negotiating the actual workflow of a certain process at runtime.

Dynamic process collaboration is the most sophisticated form of collaboration as it facilitates new forms of collaboration or enhances an existing cooperation in and between companies. One specific occurrence of Service-oriented Collaboration is Service-oriented Outsourcing, i.e., outsourcing of singular services instead of entire processes [21].

This kind of collaboration leads to different problems, e.g., besides the costs for using Web services, the Quality of Service (QoS) attributes (e.g., availability, response time, and throughput) have to be considered by service providers in order to meet the requirements of customers [6]. Further issues are the governance of the collaboration, e.g., who is responsible for meeting legal requirements and regulations [7] and monitoring of service-based collaborations [8].

In order to execute a workflow consisting of several Web services, two distinct approaches can be utilized. On the one hand the execution can be done with centralized control. Here, one control node owns the process and is responsible for the workflow execution; this approach is referred to as *orchestration*. On the other hand the execution can be done in a decentralized way. Instead of using a central orchestra-

tion node, the invoked Web services collaborate and bind themselves; this approach is referred to as *choreography*. While WSBPEL (Web Services Business Process Execution Language [9]) represents the orchestration approach, WS-CDL (Web Services Choreography Description Language [10]) deploys choreography. Both modus operandi have got their purpose – while orchestration can be used if processes are carried out inside an enterprise, a centralized control cannot be easily established if a process crosses the boundaries of an individual enterprise. In this case, choreography has to be used in order to constitute decentralized control of the workflow.

C. Related work

To the best of our knowledge, this is the first publication to present the potential benefits and risks of Service-oriented Collaboration in general and verify these considerations with results from an empirical survey. Nevertheless, several publications have presented related research results in this field in recent years.

In 2003, Zhang and Jeckle provided a basis for the research direction “Web services collaboration” by presenting a Web service lifecycle [12]. Several researchers incorporated these aspects and developed Service-oriented Collaboration middleware and frameworks with different focuses, e.g., scientific research [13], simulation of dynamic collaboration [5,14], support for creation of personalized services by end users [15], or general frameworks [16,17].

A very broad observation of decentralized multi-lateral collaborations based on SOA and Web service technologies can be found in [22]. Here, the author focuses especially on the consistency of global workflows.

However, the introduced efforts mainly focus on technological approaches. Hence, we decided to extend our previous work in the field of SOA, Web service composition, Web service workflows, replanning, optimization, and broad assessments of benefits and risks of SOA by developing a Service-oriented Collaboration model regarding potential benefits and risks of this approach [6,8,18,23].

III. METHODOLOGY AND SAMPLE CHARACTERISTICS

A. Methodology

We evaluate the potential risks and benefits of Service-oriented Collaboration with results from a survey we conducted among business/IT architects from Germany’s 1000 largest banks (with respect to balance sheet total as reported in 2003). Due to different sources, 1001 banks were invited to participate in the survey. As a large number of banks does not participate in surveys in general and a number of contacts was not able because of time constraints and other reasons, we invited 288 out of 1001 banks to fill out our online questionnaire made up from 27 questions with more than 120 variables. In total, 52 analyzable questionnaires were returned. This equals a response rate of 18.06% among the invitees and 5.19% among the 1001 largest banks.

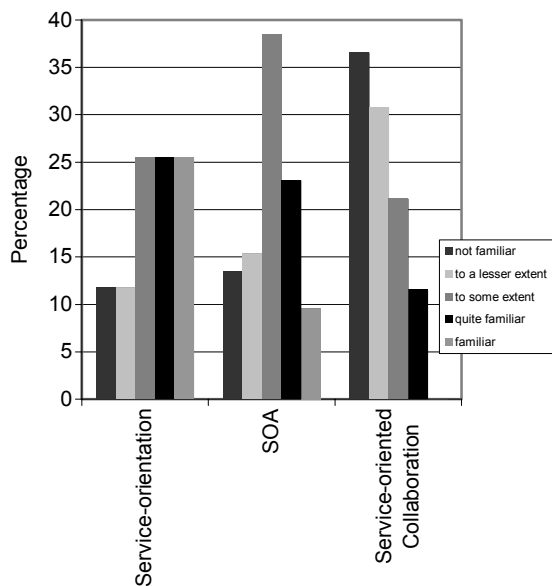


Fig. 1. Familiarity with the concepts
 Service-orientation ($n_1=51$, $\mu_1=3.41$, $\sigma_1=1.31$),
 SOA ($n_2=52$, $\mu_2=3.00$, $\sigma_2=1.15$),
 and Service-oriented Collaboration ($n_3=52$, $\mu_3=2.08$, $\sigma_3=1.03$)

Even though generalization of the results of this survey is limited due to the response rate, we believe that the results provide a good insight into the perception of Service-oriented Collaboration by business and IT architects in a certain industry. Nevertheless, the results are only indicative for other industries.

Further information about this survey can be found in [18] and [23].

B. Sample characteristics

In order to analyze the data with reference to the previous knowledge of the individual participant, we asked for a self-assessment regarding the concepts/terms “Service-orientation”, SOA, and Service-oriented Collaboration. The evaluation scale spans from “not familiar” to “familiar” on a “five-point” Likert scale.

As it is shown in Fig. 1, almost 77% of the participants are “to some extent familiar” with the concept “Service-orientation”, about 51% are “quite familiar” or “familiar” with this concept. Examining the results for the concept SOA, the figures are similar, with nearly 71% of the participants being familiar with this concept to some extent. Nearly 32% are “quite familiar” or “familiar” with the concept SOA. Only 33% of all respondents state that they are at least “to some extent familiar” with the Service-oriented Collaboration-concept, 12% are “quite familiar” with this concept. Not a single participant is “familiar” with this concept.

This response behaviour shows that service-orientation and SOA are quite well known to the participants of our survey. However, Service-oriented Collaboration is only known to 33% of those surveyed – hence, we can interpret

that even though Service-oriented Collaboration is a research topic of increasing importance, the adaptation of this concept in the German banking industry is not very common.

IV. POTENTIAL RISKS AND BENEFITS OF SERVICE-ORIENTED COLLABORATION

Potential risks and benefits of Service-oriented Collaboration often results from the same aspects. E.g., outsourcing of certain services on the one hand will probably result in cost savings. But on the other hand, in-house skills will decrease and lead to a loss of autonomy.

In the following, we present potential risks and benefits of Service-oriented Collaboration. Furthermore, these considerations are evaluated by results from our survey. These risks are primarily applicable if cross-organizational collaboration is regarded.

A. Risks of Service-oriented Collaboration

The term *risk* is primarily considered from a business-centric view. Hence, risks are conditions or events that can cause the non-accomplishment of business goals and strategies. In order to assess the business-related risks of Service-oriented Collaboration, the following three criteria were identified by a panel of experts prior to our empirical study:

- *Loss of autonomy* might result from different causes. As described above, one possible reason is the loss of in-house skills due to outsourcing. In general, loss of autonomy can occur whenever an organisation relies too much on another organisation.
- *Profile loss with reference to the customers* occurs if a customer does not recognize the manufacturer of an acquired product. This applies both to physical products and supply of services like bank loans and is especially problematic if a company depends on high customer loyalty.
- *Easier exchangeability of offered products resulting from increasing specialization* refers to the fact that it is easier for potential customers to switch between the products of different providers if those are standardized and specialized.

All risks were rated by the survey participants on a five-point Likert scale spanning from “no risk” to “very high risk”. As it can be seen in Fig. 2, *loss of autonomy* has got the highest mean (3.38) of all specified risks. 59.62% of all participants deem this risk as “high” or “very high”. Service-oriented Collaboration-experienced IT experts (i.e., participants that considered themselves to be “quite familiar” with this concept, cp. Sect. III), assess *loss of autonomy* significantly lower on the 0.10 level than all other participants (cp. Tab. 1).

With a mean of 3.10, *easier exchangeability of offered products resulting from increasing specialization* is rated relatively low. Only 26.92% of all respondents deem this risk as “high” or “very high”.

Profile loss with reference to the customers has got the lowest mean (2.50) of the specified risks. 9.62% of all par-

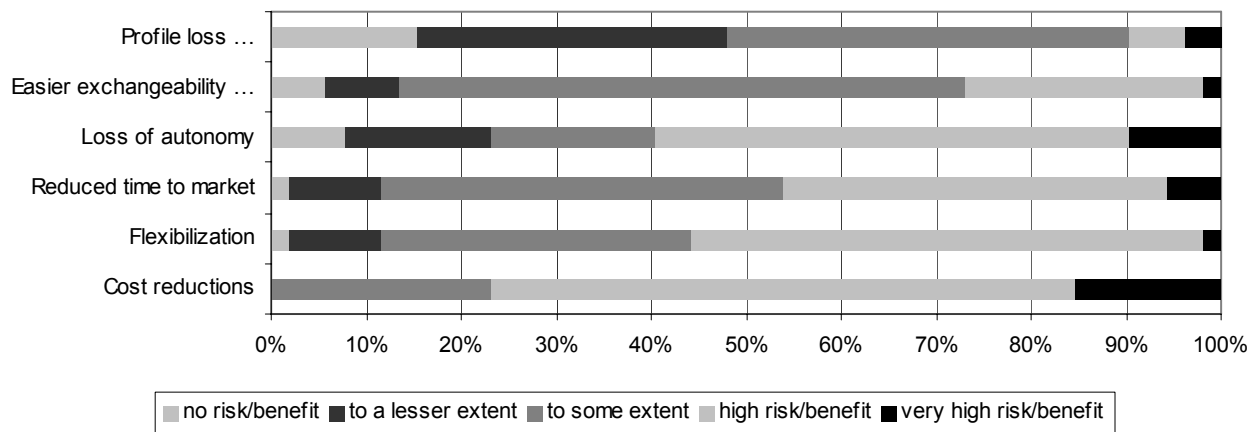


Fig. 2. Potential risks and benefits of Service-oriented Collaboration (n=52)

Participants deem this risk as “high” or “very high”. Large banks (i.e., with a balance sheet total larger than 10 billion Euro) rate this risk significantly lower at the 0.10 level than all other banks. This might be explained by the fact that for very large banks the recognition of single products and processes by the customer is more difficult than for smaller banks.

B. Benefits of Service-oriented Collaboration

In addition to the identification of the already introduced potential risks, the following three benefits of Service-oriented Collaboration were identified and assessed by the participants of our survey:

- *Cost reductions* may occur because of various reasons. Major reasons at the business level are the easier recomposition and reuse of business services and processes and improved financial reporting. At the IT level, easier implementation and deployment of new software, easier maintenance of existing systems and the further use of legacy systems will lead to reduced costs. An elaboration of SOA- and Service-oriented Collaboration-related cost reductions can be found in [18].
- Service-oriented Collaboration allows the representation of Business Process Management (BPM) models through the coordinated composition of business-centric services and is therefore suitable to manage flexible and agile business processes. Hence, *flexibilization* is one of the major benefits of Service-oriented Collabo-

ration.

- Today’s enterprise application systems are often not able to reflect desired changes in a company’s organizational structure and become a bottleneck for its further development. SOA is able to reduce this bottleneck as workflows/processes can be mapped directly to services. Hence, new products and services can be launched with *reduced time to market*.

All benefits were rated by the survey participants on a five-point Likert scale spanning from “no benefit” to “very high benefit”. Tab. 1 shows that cost reductions has got the highest mean of 3.92. The relative low standard deviation of 0.62 strengthens the particular relevance of this criterion as it implies a close distribution of the individual answers. 76.92% of all participants rate this benefit “high” or “very high” (cp. Fig. 2). Service-oriented Collaboration-experienced IT experts (i.e., participants that considered themselves to be “quite familiar” with this concept, cp. Sect. III), assess *cost reductions* significantly higher on the 0.05 level than all other participants.

The same applies to the potential benefit *flexibilization*. While the overall mean is 3.44, Service-oriented Collaboration-experts rate this benefit significantly higher at the 0.10 level than all other participants. Altogether, 55.77% rate this benefit “high” or “very high”.

Reduced time to market features the lowest mean (3.38) of all observed potential benefits. 46.15% of all respondents rate this benefit “high” or “very high”. Again, Service-oriented Collaboration-experts assess this benefit to be sig-

Risk / Benefit	Overall		Service-oriented Collaboration experts		Remaining participants	
	μ_1	σ_1	μ_2	σ_2	μ_3	σ_3
Cost reductions	3.92	0.62	4.33	0.52	3.87	0.62
Flexibilization	3.44	0.78	4.00	0.63	3.37	0.77
Reduced time to market	3.38	0.82	4.17	0.75	3.28	0.78
Loss of autonomy	3.38	1.11	2.67	1.51	3.48	1.03
Profile loss ...	3.10	0.96	3.17	0.75	3.09	0.89
Easier exchangeability ...	2.50	0.80	2.33	1.51	2.52	0.81 ₅₈

Tab. 1. Potential Risks and Benefits of Service-oriented Collaboration (n=52)

nificantly higher than all other participants at the 0.05 level.

C. Interpretation of results

If comparing the presented risks and benefits of Service-oriented Collaboration, two major findings are especially noticeable. Firstly, the means of benefits prevail over those of risks. Hence, we interpret that the overall benefits of Service-oriented Collaboration are bigger than the overall risks that might occur if adopting service-oriented technologies for collaboration. Service-oriented Collaboration is suited to improve the cooperation between companies.

Secondly, the response behaviour depends highly on the individual knowledge of the respondents, especially with regard to the presented benefits. Higher Service-oriented Collaboration-knowledge implies a higher assessment of potential benefits. This applies to the risk *loss of autonomy* as well – Service-oriented Collaboration-experts rate this risk *lower* than all other participants.

Unsurprisingly, *cost reduction* possesses the highest mean of all presented criteria by far. This result leads to the conclusion that regardless of which possibilities SOA and Service-oriented Collaboration provide, savings of costs remains the most required effect of an SOA-adaptation. Furthermore, the respondents regard Service-oriented Collaboration to be able to achieve this objective.

According to the survey participants, *loss of autonomy* is the most estimated risk of Service-oriented Collaboration. This risk is quite common if services are outsourced. However, if the vision of service marketplaces or public available service repositories will come true [20], this risk will not play a decisive role as one service might be replaced by another service from such a repository.

V. SUMMARY AND FUTURE WORK

In this paper, we presented general considerations about potential benefits and risks of Service-oriented Collaboration. Furthermore, we evaluated these considerations with results from a survey we conducted among business/IT architects from Germany's 1001 largest banks. Although the results of one particular German industry can only be indicative for other industries in other countries, the findings of this paper show an interesting trend that should be taken into account if regarding the current impact of Service-oriented Collaboration.

The results are especially relevant if the usage of Service-oriented Collaboration is regarded in a company. Furthermore, the importance of business-related benefits and risks implies that economic aspects have to be considered by experts in the field of Service-oriented Collaboration.

It has been shown that these banks rate potential benefits and risks of Service-oriented Collaboration quite different: While cost reduction is the most expected benefit, flexibilization and reduced time to market play less important roles. The most considered risk of Service-oriented Collaboration is loss of autonomy due to the reduction of in-house skills. Easier exchangeability of offered products resulting from increasing specialization is also considered as a potential

risk, but profile loss with reference to the customers is only of marginal relevance. Of course, our list of benefits and risks is not complete, but nevertheless the results show an interesting trend: Even though SOA and Service-oriented Collaboration provide new opportunities for collaboration, the main objective of acquiring the possible features of these concepts is the reduction of costs.

Furthermore, it is shown that Service-oriented Collaboration is rather unknown compared to the concepts "Service-orientation" and SOA. This observation shows that Service-oriented Collaboration is still not really recognized in practice. It is a necessity for scientists and companies from this field to propagate the potential benefits of this approach to collaboration.

As a conclusion, the results of this paper show the anticipations of the German banking industry towards SOA and Service-oriented Collaboration. These outcomes are indicative for similar industries with a comparable high paced business environment. Service-oriented Collaboration is suited to improve the cooperation and collaboration of organizations and offers new opportunities for further cost reductions.

The results of our survey should be further investigated, especially with respect to the adaptation of SOA and Service-oriented Collaboration. In order to investigate the propagation of service-oriented technologies in different banking groups in Germany, we will set up a multi-participant case study in cooperation with the E-Finance Lab e.V. and IBM. Goal of this case study is to analyze the different strategies the banks and their service organizations are following while implementing SOA as well as the impact of the SOA implementation on the affiliated credit unions and savings banks.

As the presented survey is limited to a snapshot perspective, we will conduct further surveys in the next years in order to show the development of SOA in the German banking industry. This is particularly interesting with regard to the poor recognition of the Service-oriented Collaboration-concept in this industry.

Furthermore, the application of Service-oriented Collaboration raises different issues regarding the governance of these collaborations, e.g., who is responsible for meeting legal requirements and regulations. Hence, we will extend our work on Service-oriented Collaboration with regard to SOA governance and compliance.

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VII. REFERENCES

- [1] K. Channabasavaiah, K. Holley, and E. Tuggle Jr., "Migrating to a service-oriented architecture, Part 1" IBM Developer Works, <http://www-128.ibm.com/developerworks/library/ws-mifratesoa/>, accessed at 2007-09-19, 2003.
- [2] D. Krafzig, K. Banke, and D. Slama, *Enterprise SOA: Service-Oriented Architecture Best Practices (The Coad Series)*, Prentice Hall PTR, Upper Saddle River, NJ, USA: 2004.
- [3] F. A. Rabhi, H. Yu., F. T. Dabous, and S. Y. Wu., "A service-oriented architecture for financial business processes" *Information Systems and E-Business Management*, Vol. 5, No. 2, March 2007, pp. 185-200.
- [4] D. Woods and T. Mattern, *Enterprise SOA: Designing IT for Business Innovation*, O'Reilly Media, Inc., USA: 2006.
- [5] W. T. Tsai, Q. Huang, X. Sun, and Y. Chen, "Dynamic Collaboration Simulation in Service-Oriented Computing Paradigm" in *Proceedings of the 40th Annual Simulation Symposium (ANSS'07)*. IEEE Computer Society, Washington, DC, 2007, pp. 41-48.
- [6] R. Berbner, M. Spahn, N. Repp, O. Heckmann, and R. Steinmetz, "Heuristics for QoS-aware Web Service Composition" in *Proceedings of the 2006 IEEE International Conference on Web Services (ICWS 2006)*. IEEE Computer Society, Washington, DC, 2006, pp. 72-79.
- [7] P. Weill and J. W. Ross, *IT Governance*, Harvard Business School Press, Boston, MA, USA: 2004.
- [8] N. Repp, R. Berbner, O. Heckmann, and R. Steinmetz, "A Cross-Layer Approach to Performance Monitoring of Web Services", in *Proceedings of the IEEE ECOWS'06 Workshop on Emerging Web Services Technology*, 2006, pp. 19-30.
- [9] OASIS, "Web Services Business Process Execution Language Version 2.0 Primer" http://www.oasis-open.org/committees/documents.php?wg_abbrev=wsbpel, accessed at 2007-10-10, 2007.
- [10] W3C, "Web Services Choreography Description Language Version 1.0" W3C Recommendation Candidate 9 November 2005, <http://www.w3.org/TR/ws-cdl-10/>, accessed at 2007-10-10, 2005.
- [11] C. Peltz, "Web Services Orchestration and Choreography" *IEEE Computer*, 36, 10, October, 2003, pp. 46-52.
- [12] L.-J. Zhang and M. Jeckle, "The Next Big Thing: Web Services Collaboration", in *Proceedings of the 2003 International Conference on Web Services – Europe (ICWS-Europe 2003)*, LNCS 2853, Springer, Berlin, Heidelberg, 2003, pp. 1-10.
- [13] Y. Zhao, D. Ma, C. Hu, M. Liu, Y. Huang, "SOCOM: A Service-Oriented Collaboration Middleware for Multi-User Interaction with Web Services based Scientific Resources", in *Proceedings of the Sixth international Symposium on Parallel and Distributed Computing (ISPDC'07)*. IEEE Computer Society, Washington, DC, 2007.
- [14] W. T. Tsai, Q. Huang, J. Xu, Y. Chen, and R. Paul, "Ontology-based Dynamic Process Collaboration in Service-Oriented Architecture" in *Proceedings of the IEEE International Conference on Service-Oriented Computing and Applications (SOCA'07)*. IEEE Computer Society, Washington, DC, 2007, pp. 39-46.
- [15] J.-Y. Chen, "Architecting a Service-Oriented Collaborative Web", in *Proceedings of the Advanced International Conference on Telecommunications and International Conference on Internet and Web Applications and Services (AICT/ICIW 2006)*. IEEE Computer Society, Washington, DC, 2006.
- [16] I. Jorstad, S. Dustdar, D. V. Thanh, "A Service Oriented Architecture Framework for Collaborative Services", in *Proceedings of the 14th IEEE international Workshops on Enabling Technologies: Infrastructure For Collaborative Enterprise(WETICE'05)*. IEEE Computer Society, Washington, DC, 2005, pp. 121-125.
- [17] B. Orriens and J. Yang, "Bridging the Gap between Business and IT in Service Oriented Business Collaboration", in *Proceedings of the IEEE International Conference on Services Computing (SCC 2005)*. IEEE Computer Society, Washington, DC, 2005, pp. 315-318.
- [18] S. Schulte, N. Repp, R. Berbner, R. Steinmetz, and R. Schaarschmidt, "Service-Oriented Architecture Paradigm: Major Trend or Hype for the German Banking Industry?", in *Proceedings of the 13th Americas Conference on Information Systems (AMCIS 2007)*, Keystone, Colorado, 2007.
- [19] L. Clement, A. Hately, C. von Riegen, and T. Rogers (eds.), "UDDI Version 3.0.2 – UDDI Spec Technical Committee Draft", <http://uddi.org/pubs/uddi-v3.0.2-20041019.htm>, accessed at 2007-10-12, OASIS Standard, 2004.
- [20] M. P. Papazoglou, "Service-Oriented Computing: Concepts, Characteristics and Directions", in *Proceedings of the 4th International Conference on Web Information Systems Engineering (WISE 2003)*, IEEE Computer Society, Washington, DC, 2003, pp. 3-12.
- [21] W.-T. Balke and A. Badii, "Assessing Web Services Quality for Call-by-Call Outsourcing", in *Proceedings of the 4th International Conference on Web Information Systems Engineering (WISE 2003)*, IEEE Computer Society, Washington, DC, 2003, pp. 173-181.
- [22] A. Wombacher, *Decentralized establishment of consistent, multi-lateral collaborations*, PhD Thesis, Technische Universität Darmstadt, Fachbereich Informatik, Darmstadt, Germany, <http://elib.tu-darmstadt.de/diss/000652/>, accessed at 2007-10-01. 2005.
- [23] S. Schulte, N. Repp, J. Eckert, R. Berbner, K. von Blanckenburg, R. Schaarschmidt, and R. Steinmetz, "General Requirements of Banks on IT Architectures and the Service-oriented Architecture Paradigm" in *Proceedings of the 3rd International Workshop on Enterprise Applications and Services in the Finance Industry (FinanceCom 2007)*, 2007.