

07061 Abstracts Collection
Autonomous and Adaptive Web Services
— Dagstuhl Seminar —

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Abstract. From 4.2.2007 to 9.2.2007, the Dagstuhl Seminar 07061 “Autonomous and Adaptive Web Services” was held in the International Conference and Research Center (IBFI), Schloss Dagstuhl. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

Keywords. **I.2.12** Intelligent Web Services and Semantic Web, **D.2.11** Software Architectures, **C.2.4** Distributed Systems, **D.2.4** Program Verification, **D.2.12** Interoperability.

07061 Executive Summary – Autonomous and Adaptive Web Services

The Dagstuhl Seminar on Autonomous and Adaptive Web Services brought researchers together whose current research interests are centered around web services composition and adaptation.

Web Services provide the universal basis for the integration of networked applications and business processes that are distributed among the most disparate entities, both within and across organizational borders. The fundamental idea of Web Services is that applications are built by interacting with and composing external components – services – that are available on the Web, and that are not under the control of a single party or stakeholder. A new challenge arises from this idea: the success of service oriented applications is unavoidably depending on the capability of a service to autonomously adapt to an environment that is not fully under control. Therefore a need exists for techniques that enable the flexible composition and adaptation of web services.

The participants of the seminar discussed to which extent a fully automatic composition and self-adaptation of web services is possible and which prerequisites have to be fulfilled in order to enable such a high degree of autonomy. Two main technologies were reflected in the presentations: First, approaches to the semantic web that improve the precise semantic descriptions of web services played an important role in the discussion. The resulting semantic web services and their role in service-oriented architectures were discussed by several participants.

Second, formal analysis and verification techniques that provide the foundation for composition and adaptation algorithms that sometimes made use of semantic web services were presented. Petri net techniques, model checking and process calculi were discussed in detail and their opportunities and limitations explored.

A tools session offered interesting insights into the capabilities of various tools and allowed participants to compare and position their approaches in detail.

The seminar showed that web services, semantic web, and service composition and adaptation are quickly moving areas at the moments. Progress in the various areas enables novel solutions to be built that enable fascinating applications.

Our gratitude goes to the scientific directorate of Schloss Dagstuhl for giving us the possibility of organizing this workshop. Andreas Schroeder collected the abstracts and carefully edited this report. Moreover, the workshop would not have been possible without the help of the friendly and efficient staff of Schloss Dagstuhl. Our sincere thanks go to all of them.

Keywords: **I.2.12** Intelligent Web Services and Semantic Web, **D.2.11** Software Architectures, **C.2.4** Distributed Systems, **D.2.4** Program Verification, **D.2.12** Interoperability

Privacy Aware Web Services Protocol Replaceability

Salima Benbernou (LIRIS - Lyon 1, F)

In the area of Web services and generally service oriented architecture, business protocols become necessary a part of Web services description. The work based on the business protocols, provided mechanisms for analyzing the compatibility and the substitution called *replaceability of Web services* based on their functional properties. Whereas, in this paper, we focus on the replaceability analysis which is one of the main challenges of Web services. Whether a service can replace another, depends not only on their functional properties but also of the non functional requirements, for instance privacy policies. Thus, in this paper, we propose a privacy aware protocol replaceability approach to extend the work on business protocol based on the functional aspects by the privacy properties. We introduce a model of privacy rules and its integration in the business protocols which become *Private business protocols*. Finally, a private replaceability analysis of private business protocols is discussed. It is concerned with verifying whether one private business protocol can support the same set of conversations with respect to the privacy requirements.

Keywords: Business protocol, privacy, replaceability

Joint work of: Guermouche, Nawal; Benbernou, Salima; Coquery, Emmanuel; Hacid, M.S.

Dynamic Software Architectures for Global Computing

Antonio Bucchiarone (IMT - Lucca, I)

Several recent research efforts have focused on the dynamic aspects of software architectures providing suitable models and techniques for handling the run-time modification of the structure of a system.

A large number of proposals for addressing dynamic architectures at many different levels of abstraction have been recently provided, such as programmable, ad-hoc, self-healing and self-repairing among others.

It is then important to have a clear picture of the relations among these proposals. Our work is a contribution in this line. In particular, we map several notions of dynamicity into the same formal framework (i.e. graph grammar) in order to distill the similarities and differences among them.

As a result we provide a characterization of different styles of architectural dynamisms in term of graph grammars. The theory is applied over a scenario of the Automotive Software System running example.

Keywords: Dynamic Software Architecture, Global Computing, Service Oriented Computing

Toward Optimal and Efficient Adaptation in Web Processes

Prashant Doshi (University of Georgia, USA)

Support for dynamic environments is a key challenge for scientific and business processes. This talk will identify and categorize some of the sources of volatility within a process environment and focus on ways to address the challenges in automatically adapting processes to the volatile environment. Specifically, we look at models and methods that address three key objectives. First is to adapt without violating the inter-activity coordination constraints within the process. Second is to provide guarantees of optimality of the adapted process with respect to its current environment, and third is to promote computational efficiency in performing the adaptation. Previous related research has mostly focused on verifying the correctness of manually adapted workflows. We adopt a service-oriented architecture (SOA) to realize the processes and the proposed techniques for adaptation.

Towards Context-based Autonomic Services

Schahram Dustdar (TU Wien, A)

In today's systems' landscape devices are increasingly becoming smaller, faster and are always connected to a network. These properties lead to a situation where the information systems have to operate in open dynamic infrastructures.

The constituents of such systems, people and software services, are being integrated into evolving "solutions". Often they fulfill critical societal missions. In this talk we presented the novel mechanisms for managing the interaction dynamics of future autonomic and context-aware services.

Keywords: Context-aware systems, Service-oriented Computing, Autonomic Computing

Processes for Disaster Management

Dirk Fahland (HU Berlin, D)

We present the problem of and a possible solution for supporting processes for disaster management. The processes in disaster management usually involve various cooperating organizations and people who are spatially distributed. They need to obtain data from the disaster area and exchange information while critical infrastructure on the "last mile" might not be available. The research project METRIK suggests using self-organizing wireless sensor networks to cover the last mile and construct a distributed information system that supports the flow of information between the involved parties.

This envisioned solution has to support the processes for disaster management that are used today and that have been proven to be reliable. A case study with the GeoForschungsZentrum Potsdam has shown that the processes involve largely human-enacted tasks. The processes are underspecified on purpose to provide the freedom of adjusting the process to the given situation and its limitations.

We therefore face the problem of coordinating underspecified processes with a distributed information system. For reasoning about the system and guaranteeing correctness, we need an analyzable model. As the underspecified process description might not yield a complete operational model, we suggest using declarative modeling with the help of temporal logics to formally capture the degree of freedom at an appropriate level.

We found the Alternating-time Temporal Logic (ATL) to be suitable for our needs as it allows specifying constraints on the execution of a process' tasks in an open system: component X guarantees that task A is never executed before task B . It is possible to synthesize an operational model from an ATL formula. This relation allows formalizing and hopefully answering a number of open research questions in the field of processes for disaster management. In the future, we will focus mainly on adaptivity of processes and their self-stabilizing properties.

Keywords: Processes, disaster management, information system, wireless sensor network, adaptive, workflow, self-organizing, self-stabilizing

Towards Analyzing Declarative Workflows

Dirk Fahland (HU Berlin, D)

Enacting tasks in a workflow cannot always follow a pre-defined process model. In application domains like disaster management workflows are partially specified and circumstances of their enactment change. There exist various approaches for formal workflow models that are effective in such situations, like declarative specifications instead of operational models for formalizing flexible workflow process. These powerful models leave a gap to existing techniques in the domain of workflow modeling, workflow analysis, and workflow management.

In this paper we bridge this gap with a compositional mechanism for translating declarative workflow models to operational workflow models. The mechanism is of a general nature and we reveal its principles as we provide an exemplary definition for translating DecSerFlow models based on LTL to Petri nets. We then demonstrate its use in analyzing and refining declarative models.

Keywords: Workflow, declarative, temporal logic, flexible, adaptive, analysis, transformation, Petri net

Full Paper: <http://drops.dagstuhl.de/opus/volltexte/2007/1033>

Semantically Enabled Service-Oriented Architectures: A Paradigm Shift in Computer Science

Dieter Fensel (Universität Innsbruck, A)

After four decades of rapid advances in computing, we are embarking on the greatest leap forward in computing that includes revolutionary changes at all levels of computing from the hardware through the middleware and infrastructure to applications and more importantly in intelligence. This paper outlines a comprehensive framework that integrates two complimentary and revolutionary technical advances, Service Oriented Architectures (SOA) and Semantic Web, into a single computing architecture, that we call Semantically Enabled Service Oriented Architecture (SESA). While SOA is widely acknowledged for its potential to revolutionize the world of computing, that success depends on resolving two fundamental challenges that SOA does not address, integration, and search or mediation. In a services oriented world, billions of services must be discovered and selected based on requirements, then orchestrated and adapted or integrated. SOA depends on but does not address either search or integration. The talk provides a vision of the future enabled by our framework that places computing and programming at the services layer and places the real goal of computing, problem solving, in the hands of end users.

Keywords: Intelligent Web Services and Semantic Web, Software Architectures

Composing Web-service-like abstract state machines (ASM)

Andreas Friesen (SAP Research - Karlsruhe, D)

The presentation provides an overview on semi-automatic design of Collaborative Business Processes for B2B/EAI integration in the EU project FUSION. The introduced Enterprise Application Integration Ontology and a mediator-based run-time architecture for CBPs integrating heterogeneous web services enabled enterprise systems build the corner stones of the FUSION solution. The functionality and the building blocks of the Collaborative Business Process Designer are discussed in detail. The talk provides then an example demonstrating initial ideas for generating an executable collaborative business process out of a CBP template automatically.

Keywords: Business process composition, collaborative business processes, Web service composition, enterprise application integration, business-to-business integration

Joint work of: Friesen, Andreas; Lemcke, Jens

Full Paper: <http://drops.dagstuhl.de/opus/volltexte/2007/1034>

Techniques for Semantics empowered SOA with focus on dynamic and adaptive Web services and processes

Karthik Gomadam (Wright State University, USA)

Karthik Gomadam, Kno.e.sis Center, Wright State University, Dayton, OH.

Techniques for Semantics empowered SOA with focus on dynamic and adaptive Web services and processes

The emergence of Service Oriented Architectures (SOA) has created a new paradigm of loosely coupled distributed systems. Most of the research work in the area of SOA and the Web services implementation of SOA have focused on adding more dynamism and adaptability to the SOA . In the METEOR-S project, we seek to add semantics at different levels in SOA. The guiding principle behind our approach are the four types of semantics, presented by Dr. Amit P. Sheth.

One of the initial contributions of the METEOR-S project was adding semantics to Web Service Description Language [1] . Leveraging on the ability to enhance service descriptions with semantics, the METEOR-S framework was developed to address issues related to dynamic binding [2, 3], Enhancing UDDI for sophisticated publication and discovery of services [4], Multi paradigm constraint analysis [5], Semantic Agreement Matching [6] and Adaptation of Web

Processes [7] The unique aspect of our work so far is our conformance to current WS-standards and specifications.

In this talk, I will focus on the METEOR-S Adaptation Framework for Event Identification and Adaptation. I will introduce the notion of semantic templates, formal modeling of semantic templates and discuss approaches to identifying events of importance from semantic templates and also our approach to Web process adaptation, along with inter-service dependencies.

References

1. Kaarthik Sivashanmugam, Kunal Verma, Amit P. Sheth, and John A. Miller. Adding Semantics to Web Services Standards. In *International Conference on Web Services (ICWS'03)*, 2003.
2. Kunal Verma, Karthik Gomadam, Amit P. Sheth, John A. Miller, and Zixin Wu. The METEOR-S Approach for Configuring and Executing Dynamic Web Processes, LSDIS Technical Report.
3. Karthik Gomadam, Kunal Verma, Amit P. Sheth, and John A. Miller. Demonstrating Dynamic Configuration and Execution of Web Processes. In *ICSOC 2005*, pages 502–507, 2005.
4. Kunal Verma, Kaarthik Sivashanmugam, Amit P. Sheth, Abhijit Patil, Swapna Oundhakar, and John A. Miller. METEOR-S WSDI: A Scalable Infrastructure of Registries for Semantic Publication and Discovery of Web Services. *Journal of Information Technology and Management, Special Issue on Universal Global Integration*, 6(1):17–39, 2005.
5. Rohit Aggarwal, Kunal Verma, John A. Miller, and William H. Milnor. Constraint Driven Web Service Composition in METEOR-S. In *Proceedings of IEEE SCC 2004*, 2004.
6. Nicole Oldham, Kunal Verma, Amit P. Sheth, and Farshad Hakimpour. Semantic WS-Agreement Partner Selection. In *Proceedings of 15th International World Wide Web Conference (WWW2006)*, 2006.
7. Kunal Verma, Prashant Doshi, Karthik Gomadam, John A. Miller, and Amit P. Sheth. Optimal Adaptation in Web Processes with Coordination Constraints. In *2006 IEEE International Conference on Web Services (ICWS 2006)*, 2006.

CMC - An adaptive model checker

Moritz Hammer (Universität München, D)

CMC is a disk-based model checker that has been written using component technology. Using components proved a good way to investigate different combinations of algorithms, and at the same time is competitive enough to tackle really large models. We present the current algorithm that features "smooth degradation" - the ability to gradually adapt to increasing memory requirements by employing the hard disk. We also discuss how an adaptive choice of components during runtime might further improve the model checker.

Business-Process Anti-patterns: How to avoid the common errors in Business process modeling

Jana Koehler (IBM Research - Zürich, CH)

The talk gave an overview on the current activities of the business integration technologies group in the IBM Zurich Research Laboratory. The group focuses on the paradigm of business-driven development - a software engineering approach that focuses on business processes and their implementation in a service-oriented architecture.

Three topics were discussed:

- the modeling of object life cycles and the relation between data and processes
- the problem of managing change and several versions of a process or service
- the challenge of assuring the quality of process models when they evolve from an informal documentation to an adequate and consistent specification of an IT system.

Keywords: Business-driven development, business process modeling, service-oriented architecture

Joint work of: Koehler, Jana; Kuester, Jochen; Ryndina, Ksenia; Vanhatalo, Jussi

Full Paper:

http://www.choose.s-i.ch/Events/forum2006/Koehler_Vanhatalo_CHOOSE_06.pdf

Adaptive Services Grid

Dominik Kuroпка (Hasso-Plattner-Institut - Potsdam, D)

The Adaptive Services Grid (ASG) project provides a platform for semantic service provisioning which implements agility and adaptiveness promised by Service-oriented Architectures. Based on available standards, a solution for the complete service provisioning lifecycle has been built. A key concept of this solution is the usage of semantic information about services to automatically plan, enact, and monitor service compositions to fulfill user requests.

Keywords: Semantic services, adaptivity

A Classification of UML2 Activity Diagrams

Jochen Küster (IBM Research - Zürich, CH)

We present the results of a case study where we investigated a semantic mapping of UML2 activity diagrams to the pi-calculus.

Our study was initiated by recent discussions on the role of the pi-calculus for future business-process management systems as well as our interest in developing formal analysis techniques for activity diagrams.

The study revealed interesting insights into the semantic expressivity of activity diagrams and the semantic nature of the different modeling elements, in particular of object nodes and activity final nodes. We show that for certain types of diagrams, a semantic mapping of object nodes, in particular of pins, to message reading and receiving operations is insufficient and propose an encoding of pins as pi-processes. Our results motivated us to present a novel classification of activity diagrams based on their semantic expressivity.

Keywords: UML2 Activity Diagrams, semantics, pi-calculus

Joint work of: Koehler, Jana; Kster, Jochen; Novatnack, John; Ryndina, Ksenia

A Modelling Approach for Service Component Architectures

Antonia Lopes (University of Lisboa, P)

We report on a formal approach and modelling languages being developed within the SENSORIA project for supporting service-oriented modelling at high levels of abstraction, i.e. independently of the hosting middleware and hardware platforms, and the languages in which services are programmed. More specifically, we give an account of the concepts and techniques that support the composition model, i.e. the mechanisms through which complex applications can be put together from simpler components, including the language primitives we have developed for the orchestration of components and the definition of external interfaces.

Process Calculi for Long Running Transactions

Hernan Melgratti (IMT - Lucca, I)

Transactions are a common coordination problem of global computing applications. Typically, several autonomous components, which are distributed over the web, require to be guaranteed about the successful execution of the others, or otherwise to be made aware of the failure of some partner. In this talk we will discuss about the different process calculi proposed in the literature for expressing transactions in global computing.

Reconfigurable Architecture Designs with Constraints

Ugo Montanari (Università di Pisa, I)

The talk outlines a first contribution concerning software architectures and their reconfigurations, and a second one about a nominal process calculus with constraints for specifying service level agreements. The two lines are under development within the European IST FET project SENSORIA and will yield a uniform approach for designing reconfigurable architecture designs equipped with constraints.

The first contribution (in collaboration with Dan Hirsch) proposes a type-based framework for software architecture styles and their consistent reconfigurations, where graph types are based on shapes (i.e. styles) and reconfigurations are guaranteed to be shape-preserving. Style (or shape) checking implies that an architecture is an instance of some Software Architecture (SA) Style that characterizes a class of structures exhibiting a common pattern. Typing proofs define a general framework based on inference rules where shape rules and graphs representing system configurations are represented as type judgments. Reconfiguration has to respect shape, i.e. type. But for design, just observing the actual configuration may not be enough. Instead, observing the steps taken to obtain the final system may provide important information about the process of construction. Proof terms provide more information than just graphs about the process of constructing systems and allow to specify reconfigurations as proof term rewritings.

The second contribution (in collaboration with Maria Grazia Buscemi) proposes a simple model of contracts for QoS and SLAs that also allows to study mechanisms for resource allocation and for joining different SLA requirements. The language combines two basic programming paradigms: name-passing calculi, like pi-calculus and fusion calculus, and concurrent constraint programming (cc programming). Specifically, we extend cc programming by adding synchronous communication and by providing a treatment of names in terms of restriction and structural axioms closer to nominal calculi than to variables with existential quantification. Also, our constraint systems are based on a constraint semiring structure which allows for expressing soft constraints, networks of constraints and rich ways of combining different constraint systems.

Keywords: Software architectures, reconfiguration, nominal calculi, service level agreements, quality of service, concurrent constraint programming, constraint semirings, soft constraints, networks of constraints

Delivering Services to Mobile Users

Massimo Paolucci (DoCoMo Euro-Labs - München, D)

Delivering services to mobile users to exploit added value on the network is becoming a major part of the business model of all mobile operators. In my talk I review an emerging breed of services that are directed to the user. These services are delivered via bluetooth or NFC (Near Field Communication) technology present a number of challenges for service computing. First of all, their delivery is restricted to a limited area: bluetooth delivery is restricted to few meters, NFC to few centimeters. Second, all the interoperation problems should be solved at delivery time, since it is unfeasible that the user will take care of them. Finally, the composition of services should adapt to the user's changing needs. In the talk I present a schema for service delivery and composition that attempts to satisfy all these requirements.

Keywords: Service Mobilephone

Flexible and self-healing e-services

Barbara Pernici (Politecnico di Milano, I)

The advent of Web services, new network technologies, and new devices gives new opportunities and imposes new requirements for the design and the execution of adaptable processes. Processes can be composed using Web services, but their orchestration has to also consider users needs at runtime, where these needs are expressed as context information.

Context information is formed by functional and not functional characteristics and Web services must be selected also considering non functional aspects. In this scenario, new approaches and new frameworks have to be studied in order to overcome the limitations of the current standards, such as WSDL and WS-BPEL, which only consider functional aspects of Web services.

The talk presents the framework for adaptive web services developed at Politecnico di Milano, to select web services based on functional characteristics and QoS, to execute a context aware orchestration of processes composed of Web services. With this framework, self-healing functionality is provided to recover from failures, based on dynamic substitution and service management.

Keywords: Adaptive information systems, self-healing, autonomous services

See also: <http://www.elet.polimi.it/upload/pernici/ws-research.html>

Supporting the design and adaptation of Web service compositions

Marco Pistore (Università di Trento, I)

In the talk we describe the approach that we are developing in Trento to support the design and the adaptation of distributed business applications implemented as a set of BPEL processes. We also discuss some application domains where we are currently experimenting our techniques.

In the design task, we assume to have a set of BPEL processes corresponding to the different component services. Our goal is to support the definition of an orchestrator that combines these BPEL services in a suitable way, in order to achieve a specific composite functionality. The implementation of the orchestrator, e.g., in terms of one additional BPEL process, is a time consuming and error prone task. For this reason, we allow the designer to define the desired behavior of the orchestrator in a declarative way, as a set of composition requirements, and we use powerful automated generation techniques to produce the implementation. Our experiments show that this approach is doable, and it reduces in a very significant way the time required to implement the composition.

In the adaptation task, we assume that some component services have changed or have been replaced, and we show how the orchestrator can be adapted to interact with these new services. In particular, we show that our composition requirement language and our automated generation techniques are adequate for this task, and support a rapid adaptation of the orchestrator.

Keywords: Web Service Composition, BPEL, Adaptation, Automated generation

Service modeling from scratch

Wolfgang Reisig (HU Berlin, D)

The paradigm of "Service-oriented Computing" provides a framework for interorganizational business processes and for the emerging ideas of "programming in-the-large". Services are to be comprehensible without reference to implementation details. Interaction of services is established by their composition. This gives rise to a number of problems:

Are two services partners, i.e. do they properly compose? Does a service have partners at all (otherwise, it is definitely ill-designed)? How to characterize all partners of a service? How to represent an operating guideline for a service? Is there a canonical (most liberal) partner of a service? Can a service S' substitute a service S ? Is there a canonical (most abstract) S' to substitute S ? Can S' substitute S at runtime? How to adapt (i.e. mediate between) two services that "almost" properly compose?

Such issues can be discussed by means of models of services. We show how services can intelligibly be modelled, and we discuss algorithms and tools to analyze the above mentioned problems.

Full Paper:

<http://www2.informatik.hu-berlin.de/top/forschung/index.php?language=EN>

Role of semantics in Autonomic Web Services and Processes

Amit P. Sheth (Wright State University, USA)

Amit Sheth (<http://knoesis.org/> amit), Kno.e.sis Center (<http://knoesis.org>), Wright State University.

The emergence of Service Oriented Architectures (SOA) has created a new paradigm of loosely coupled distributed systems.

In the METEOR-S project, we have studied the comprehensive role of semantics in all stages of the life cycle of service and process— including annotation, publication, discovery, interoperability/data mediation, and composition.

Among the concrete contributions, we offered a broad framework of semantics consisting of four types [1]: 1) Data semantics: Modeling of the inputs and the outputs of a service, 2) Functional semantics:

Modeling of the functional capabilities of a service, 3) Non-Functional semantics:

Modeling the non-functional requirements and capabilities including policy and/or agreement between services and 4) Execution semantics: Modeling service execution including interaction pattern and adaptation to failure.

The data semantics is essential towards addressing issues related to data heterogeneities, which are common in service compositions and service interactions [2]. Modeling functional semantics, allows for better service discovery [3] and also helps in addressing issues in process composition. [Paper under preparation]. Non-functional semantics plays a very important role in partner selection based on requirements and guarantees. In a distributed ecosystem like SOA, it is very likely that services in different domains often want to communicate with each other. It is in this context, modeling of non-functional semantics, via mechanisms like WS-Agreement [4] or WS-Policy [5], allows for better matching and selection of partners. The SAWSDL candidate recommendation, which originally started as WSDL-S, enhances the current WSDL standard to model the data and functional semantics using WSDL.

We recognized the need for an incremental and evolutionary approach to add semantics to SOA that is consistent with W3C recommendations and industry's investment in tools and skills in Web Services related technologies. This led to our proposal for WSDL-S, which was refined in collaboration with IBM and submitted to W3C [6]. W3 Working group (of which we are a member) adopted key aspects of WSDL-S and has defined the Semantic Annotation of WSDL (SAWSDL) specification, which is now a W3C candidate recommendation.

Significant tools and use cases for SAWSDL already exist [7].

Lately we have focused on the using semantics to add dynamism and adaptability to services and processes in SOA-based systems. This led to the proposal

of Autonomic Web processes presented as a vision talk at ICSOC [8]. Here we propose a self-healing, self-optimizing framework for SOA. Modeling execution semantics is critical towards realizing that vision. Execution semantics can be used to specify, what a system should do in the event of failure during execution. In the METEOR-S project, this led to extending the notion of task skeleton, first proposed in [Krishnakumar, Sheth], towards creating an adaptation framework for Web processes.

This talk would expand on the short motivation towards the need for the four types of semantics, its standards-based support through WSDL-S/SAWSDL, and the efforts towards realizing dynamic and adaptive SOA.

References

1. Amit P. Sheth. Semantic Web Process Lifecycle: Role of Semantics in Annotation, Discovery, Composition and Orchestration. In *WWW 2003 Workshop on E-Services and the Semantic Web, Invited Talk*, 2003.
2. Meenakshi Nagarajan, Kunal Verma, Amit P. Sheth, John A. Miller, and Jonathan Lathem. Semantic Interoperability of Web Services - Challenges and Experiences. In *IEEE International Conference on Web Services (ICWS 2006)*, 2006.
3. Kunal Verma, Kaarthik Sivashanmugam, Amit P. Sheth, Abhijit Patil, Swapna Oundhakar, and John A. Miller. METEOR-S WSDI: A Scalable Infrastructure of Registries for Semantic Publication and Discovery of Web Services. *Journal of Information Technology and Management, Special Issue on Universal Global Integration*, 6(1):17–39, 2005.
4. Nicole Oldham, Kunal Verma, Amit P. Sheth, and Farshad Hakimpour. Semantic WS-Agreement Partner Selection. In *Proceedings of 15th International World Wide Web Conference (WWW2006)*, 2006.
5. Kunal Verma, Rama Akkiraju, and Richard Goodwin. Semantic Matching of Web Service Policies. In *Second International Workshop on Semantic and Dynamic Web Processes (SDWP 2005), In Conjunction with the Third International Conference on Web Services (ICWS'05)*, pages 79–90, 2005.
6. <http://www.w3.org/TR/sawsdl/>.
7. Radiant: <http://ldis.cs.uga.edu/projects/meteor-s/downloads/index.php?page=1>.
8. Kunal Verma and Amit Sheth. Autonomic Web Processes. In B. Benatallah, F. Casati, and P. Traverso, editors, *Proceedings of the Third International Conference on Service-oriented Computing (ICSOC), Lecture Notes in Computer Science (LNCS 3826)*, pages 1–11. Springer Verlag, 2005.

Keywords: Semantic Web Services, Semantics for service life cycle, Autonomic Web Processes, SAWSDL

Extended Abstract: <http://drops.dagstuhl.de/opus/volltexte/2007/1032>

Role of semantics in Autonomic and Adaptive Web Services & Processes

Amit P. Sheth (Wright State University, USA)

The emergence of Service Oriented Architectures (SOA) has created a new paradigm of loosely coupled distributed systems. In the METEOR-S project, we have studied the comprehensive role of semantics in all stages of the life cycle of service and process— including annotation, publication, discovery, interoperability/data mediation, and composition.

In 2002-2003, we had offered a broad framework of semantics consisting of four types: 1) Data semantics, 2) Functional semantics, 3) Non-Functional semantics and 4) Execution semantics. This talk describes the need for the four types of semantics, its standards-based support through WSDL-S/SAWSDL, and the need for such semantic representation to dynamic and adaptive SOA.

We also briefly review the proposal for Adaptive Web Processes introduced earlier in a ICSSOC 2005 vision talk.

Keywords: Adaptive web service, autonomic web service, adaptive web process, autonomic web process, data semantics, functional semantics, non-functional semantics, execution semantics, SAWSDL

Understanding Approaches for Composition and Execution of Web Services

Biplav Srivastava (IBM - New Delhi, IND)

Web services have received much interest due to their potential in facilitating seamless integration of business-to-business or enterprise applications. Of particular interest is the Web Service Composition and Execution (WSCE) process - the creation of a workflow that realizes the functionality of a new service and its subsequent deployment and execution on a runtime environment. A significant number of solutions have been proposed in the literature for composition and execution of web services. However, in order to choose a suitable technique for an application scenario, one needs to systematically analyze the strengths and weaknesses of each of these solutions. To this end, we present a formalization of the WSCE process, a classification of existing solutions into four distinct categories (approaches), and an in-depth evaluation of these approaches. Our evaluation is based on multiple metrics that we deem critical for a WSCE system, e.g. composition effort, composition quality, and ability to handle failures. We also present an application of this analysis to three different scenarios.

Keywords: Web services composition execution formalization

Joint work of: Agarwal, Vikas; Chaffle, Girish; Mittal, Sumit; Srivastava, Biplav

Experimenting Event Notification in Web Service Composition

Daniele Strollo (IMT - Lucca, I)

The main goal of the Service Oriented Architectures (SOAs) is to define software components which are (i) developed in a language and architecture-independent way and (ii) distributed in the web. Most of the current methodologies are focused on composition of such services and several programming languages have been recently proposed for describing aggregated services. However, it is not infrequent that such language have drawbacks. In fact, constructs are often informally specified which usually leads to ambiguities or redundancy. In this talk the prototype implementation of Java Signal Core Layer (JSCL) will be described. Basically, JSCL is a coordination language of distributed services based on an event notification paradigm and has been inspired (and its implementation driven) by the Signal Calculus, a formally defined process calculus.

Keywords: WS composition choreography

Joint work of: Strollo, Daniele; Guancia, Roberto

A Formal Framework for Interactive Agents We describe a formal framework, IAF, for

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We describe a formal framework, IAF, for specification and analysis of interactive agents.

IAF is based on the Reflective Russian Dolls model of distributed object reflection and coordination.

An interactive agent is formalized as a collection of activities (subagents) under the control of a policy-based coordinator. IA specifications are given an interaction semantics generalizing actor-based interaction semantics. The semantics is compositional both horizontally and vertically.

The framework can be used to explore the design space, study features of different points in the design space, and to develop executable specifications of specific agents and study their interactions with the environment.

Keywords: Interaction coordination reflective rewriting logic

Using Goals for Flexible Service Orchestration: A First Step

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This paper contributes to a line of research that aims to apply agent-oriented techniques in the field of service-oriented computing. In particular, we propose to use goal-oriented techniques from the field of cognitive agent programming for service orchestration. The advantage of using an explicit representation of goals in programming languages is the flexibility in handling failure that goals provide. Moreover, goals have a close correspondence with declarative descriptions as used in the context of semantic web services. This paper now presents first steps towards the definition of a goal-based orchestration language that makes use of semantic matchmaking. The orchestration language we propose and its semantics are formally defined and analyzed, using operational semantics.

Keywords: Agent-oriented programming, semantic web services, orchestration

Joint work of: Van Riemsdijk, Birna; Wirsing, Martin

Model-Driven Deployment of Services to Standards Compliant Reliable Middleware

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Due to the rapid increase in the number of available web services, more and more emphasis is put on their reliability, availability, security, etc. In order to meet such non-functional requirements, a service needs to be designed for reliability by making design decisions on a high, architectural level. We present a model-driven approach for the design and deployment of services. Starting from a platform-independent service model enriched by non-functional attributes for reliable messaging, low-level service configuration descriptors are generated for (i) standards-compliant middleware supporting reliable messaging and (ii) service discovery platforms based on semantic web technology.

Keywords: Model-driven development, service-oriented architecture, reliable messaging

Joint work of: Varró, Dániel; Gönczy, László; Ávéd, János; Kövi, András

Requirements for Implementing Business Process Models through Composition of Semantic Web Services

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Business Process models can be helpful in (at least) two ways: They can guide the execution of process instances, and they are helpful just as explicit models (documentation, explanation, discussion). When a business process model is newly created or changed, e.g., in re-design projects or due to new market opportunities or altered regulations, and the changes are to be propagated to the execution layer, machine support in this propagation is highly appreciated.

The recent years have brought afore a maturation of Web service composition techniques. When trying to apply those composition techniques to create an orchestration of Web service calls that serves as the implementation of a business process model, there are a number of particularities that need to be taken into account. This talk presented a number of such requirements for a setting where a business process model needs to be (partially) implemented. The listed requirements for composition in the context of business process implementation can be considered quite challenging not only for current technology but also in terms of computational complexity.

However, if these requirements are met by an approach to composition - potentially by combining existing technology - the relevance of automated Web service composition to enterprise application software could increase significantly. In [1], we give a list of requirements towards service composition along with a short analysis of the computational complexity. A conceptual framework as a starting point for a solution is given in [2]. The talk here focused on the requirements and a discussion of them with the seminar participants.

References

1. Ingo Weber. Requirements for the Implementation of Business Process Models through Composition of Semantic Web Services. In *Proceedings of the 3rd International Conference on Interoperability for Enterprise Software and Applications (I-ESA)*, 2007.
2. Ingo Weber, Ivan Markovic, and Christian Drumm. A Conceptual Framework for Composition in Business Process Management. In *Proceedings of the 10th Intl. Conf. on Business Information Systems BISÁŠ07*, 2007.

Keywords: Business Process Composition

See also: Requirements for the Implementation of Business Process Models through Composition of Semantic Web Services. Proceedings of the 3rd International Conference on Interoperability for Enterprise Software and Applications (I-ESA) March 2007, Funchal, Portugal

SENSORIA - Systematic Development of Service-Oriented Overlay Computers: From requirements to design of service architectures

Martin Wirsing (Universität München, D)

Service-oriented computing is an emerging paradigm where services are understood as autonomous, platform-independent computational entities that can be described, published, categorised, discovered, and dynamically assembled for developing massively distributed, interoperable, evolvable systems and applications. The IST-FET Integrated Project SENSORIA aims at developing a novel comprehensive approach to the engineering of service-oriented software systems where foundational theories, techniques and methods are fully integrated in a pragmatic software engineering approach. In this talk I present a short overview of the SENSORIA approach to the development of service-oriented systems. This includes a new generalised concept of service, new semantically welldefined modelling and programming primitives for services, new powerful mathematical analysis and verification techniques and tools for system behaviour and quality of service properties, and novel model-based transformation and development techniques. The innovative methods of SENSORIA are demonstrated by applying them in the service-intensive areas of e-business, automotive systems, and telecommunications.

Keywords: Formal methods, Service-oriented architecture, Software Engineering, Analysis

Joint work of: Wirsing, Martin; Clark, Allan; Gilmore, Stephen; Hözl, Matthias; Knapp, Alexander; Koch, Nora; Schroeder, Andreas

Services with multiple partners: How can a partner act without knowing what the others do?

Karsten Wolf (Universität Rostock, D)

Interacting services need to be compatible in several respects: at least their semantics (ontologies), their non-functional parameters, and their behaviour must fit. Behavioural compatibility is necessary, for instance, for avoiding deadlocks in the interaction between services. This talk is devoted to behavioural aspects.

For a service S with just one partner, we already have some techniques for their analysis. We can, for instance, check whether S does have behaviourally compatible partners at all. We call this property controllability. We can decide controllability through the generation of a compatible partner. Furthermore, we can operationally characterize all partners of S . We call this characterization an operating guideline for S . The operating guideline is a valuable tool for service discovery.

Some services interact with more than one partner. For instance, a travel agency interacts with a customer, a hotel reservation system, a flight reservation system and so on. The partners of the travel agency do not communicate with each other. They do not even know how the respective other partners communicate with the travel agency. Nevertheless, each partner needs to determine its own behaviour from (the public of) the travel agency service.

In the talk, we propose concepts for proper interaction with a service that has multiple partners. In particular, we adapt the concepts of controllability and operating guideline.

Keywords: Service, controllability, operating guideline