FP6 – 004617

ASG – Adaptive Services Grid

Final Activity Report

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Scientific Coordinator

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Instrument:	Integrated Project		Period covered:	from 01/09/2004 to 28/02/2007
Thematic Priority:	Information Society Technologies		Start date of project:	September 1, 2004
Strategic Objectives:	Open development platforms for software and services		Duration:	2½ years
Project coordinator	University of Potsdam			
Scientific Coordinator Name and Organisation	Dr. Dominik Kuropka Hasso-Plattner-Institute		Revision:	Final Version

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1 PROJECT SUMMARY

by Dominik Kuropka, Regina Gerber

1.1 Project Objectives

The goal of Adaptive Services Grid project is to develop an architectural blueprint and a proof-of-concept prototype of an open development platform for adaptive and reliable matchmaking discovery, composition, and enactment of services. To achieve its goal, ASG addresses scientific and technological issues making use of the knowledge and expertise of major European research institutions with significant contributions from the software, tele-communications, and telematics industry. ASG provides the integration of its sub-projects in the context of an open platform, including tool development by small and medium sized enterprises. Based on semantic specifications of requested services by service customers, ASG discovers appropriate services, creates composed services and enacts them.

1.2 Consortium Overview

The ASG consortium consists of research institutions, large companies, small and medium sized companies from large parts of Europe and Australia. The Australian partner is not funded by EU, but by local funding agencies in Australia.

01 University of Potsdam (UP), Germany

02 University of Leipzig (UL), Germany, months 01-24

03 University of Innsbruck (UIBK), Austria

04 Fraunhofer-Gesellschaft (IESE), Germany

05 DaimlerChrysler AG (DC), Germany

06 Hasso-Platter-Institute (HPI: HPI-BPT/HPI-DCL), Germany

07 National University of Ireland - Galway (NUIG), Ireland

08 Swinburne University of Technology (SWIN), Australia, months 01-24

09 Thüringer Anwendungszentrum GmbH (tranSIT), Germany

10 NIWA-Web Solutions Niederacher & Wahler OEG (NIWA), Austria, , months 01-18

11 Telenor R&D (Telenor), Norway, months 01-24

12 Siemens AG (SIE), Germany

13 Rodan Systems Spolka Akcyjna (Rodan), Poland

14 Jyvaskylan Ylipisto (JYU), Finland, months 01-24

15 Telekomunikacja Polska S.A. (TP), Poland, months 01-24

16 Otwarty Rynek Elektronicny S.A. (MP), Poland, months 01-24

17 University of Karlsruhe (TH) (UniKarl), Germany, months 01-04

18 ASTEC Sp. z o.o. (Astec), Poland

19 Akademia Ekonomiczna w Poznaniu (PUE), Poland

20 University of Applied Sciences Furtwangen (FHF), Germany

21 Polska Telefonia Cyfrowa Sp. z o.o. (PTC), Poland, months 01-24

22 Universität Koblenz-Landau (Uni Ko-Ld), Germany

23 Erik Lillevold (EL), Norway, months 04-24

24 Hanival Internet services GmbH (Hanival), Austria, months 19-30

1.3 Coordinator Contacts

The coordination activities in ASG are performed jointly by the Administrative Coordinator, the Scientific Coordinator, and the Dissemination Coordinator, where the Administration Coordinator is in charge of financial, administrative and legal administration and, as such, signed the contract with the European Commission. The responsibilities and coordination activities reflect both the regulations of the ASG EC Contract No. 004617 and the ASG Consortium Agreement.

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2 VISION, RESULTS AND EXPLOITATION

2.1 Vision of the project

Information systems play an increasingly important role in the realization of products that companies provide to the market. Typically, the functionality of several information systems needs to be combined to realize a particular product. Therefore, the seamless integration of information systems plays a key role in the development and maintenance of products. In today's dynamic market environments, change is the rule rather than the exception. Consequently, the ability to change products in an effective way and to adapt products to a changing information technology landscape, are important competitive advantages of a successful company. Existing approaches for the integration of enterprise applications fall short of providing this ease of change. The vision of the project is a more flexible and adaptive way to provide services for business environments. To achieve a higher level flexibility and adaptability a semantic-enabled, automated discovery and composition of services at run-time is necessary. Furthermore, the ability to re-bind individual services or to re-compose parts of compositions is needed to enable the platform to replace faulty services dynamically. Such an adaptive enactment is crucial if services provided by external partners are used, as their operation can often not be guaranteed.

2.2 Results achieved and limitations

To achieve the vision of flexibility and adaptability in the provision of services, the ASG project defined the following service delivery lifecycle (Figure 1), which has been detailed in the ASG architecture blueprint and implemented in two use-case scenarios.

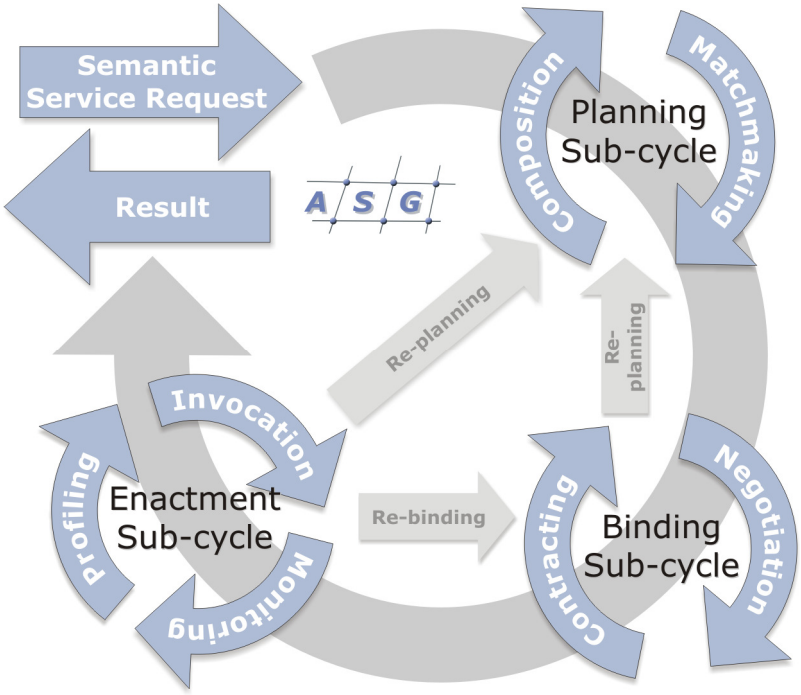

Figure 1: ASG service delivery lifecycle.

In contrast to existing service provisioning platforms, services in ASG are not directly invoked by applications (static binding) instead they are invoked by a semantic service request. A semantic service request specifies a desired service by its functionality. The ASG platform tries to find a service or a composition of services which are able to meet a posed request. The Planning Sub-cycle is the first step in processing of a semantic service and the results of this step is an abstract composition of services which are able to meet the semantic service request. Abstract composition means, that the composition does not directly bind existing services. Rather the services are represented by semantic service specifications which act as placeholders for the real services. This proceeding allows a late binding of services and features a better reusability of service compositions which is useful for performance issues.

These abstract service compositions are transformed into enact-able service compositions in the Binding Sub-cycle. This happens by binding the semantic service specifications to concrete services. In ASG two different binding strategies: binding via selection and binding via negotiation are implemented. Binding via selection means that for each activity of the composition the component asks the Semantic Service Discovery for services which are semantically matching that activity. In case several services are returned, then the “best” one of them is selected according its non-functional-properties and the optimization criteria of the semantic service request. It is worth mentioning that the ASG platform also supports a long-term profiling of services. This means that the platform is able to use monitoring data to observe the long-term behaviour of services. For example with this, it is possible to get a statistics of the average execution time of a service, or the percentage of violations of the non-functional properties like exceeding of a specified maximal duration of a service, or the percentage of failed requests due to the service being down. All these profiled data can also be used to optimize the selection of services.

Binding via negotiation is an extended form of binding which works like this: For each placeholder the platform component starts a negotiation on negotiable service properties with all matching services. The platform tries to find a combination of services for all activities, which fits as good as possible to the optimization criteria of the semantic service request. Negotiation builds up on the idea that non-functional properties of a service are not static but can be negotiated dynamic at run-time. For example it might be useful to specify the maximal duration of a service execution or the costs in relation to the load on the service infrastructure providing a particular service. When an agreement with a particular service is achieved a digital contract it is set up and digitally signed by both parties. The result of the Binding Sub-Cycle is a usual BPEL document in which all activities are bound to concrete services.

The third step in processing of semantic service requests is the Enactment Sub-cycle. It receives enact-able service compositions from the Binding Sub-cycle and enacts them. In the project we have used the commercial Rodan ObjectOffice Workflow™ Engine for the enactment of service compositions as workflow. ASG solves the challenge of integration via the use of service proxies which are all aligned to a common ontology and data structure. For the execution of an activity the workflow engine asks the platform for a proxy representation of the proper service. In the next step, the proxy is called all input data is send to the proxy. The proxy takes care of a proper data type and protocol transformation and calls the real service. In case the service returns some data, this data is transformed in a way that it is compatible to the data schema specified by the domain ontology of the platform. By receiving the data from the proxy, the workflow engine can successfully close the activity and continue. After successful enactment of the whole service composition the final result is collected and it is send back to requester of the semantic service request.

The ASG service delivery life-cycle includes two mechanisms to handle dynamics when it comes to explicitly considered or unconsidered failures of services: re-binding and re-planning. Considered failures are well known failures which might occur during the execution of a service and are therefore explicitly specified as possible (even though not desired and therefore hopefully seldom) results of a service. One example for such a considered failure is the rejection of credit card by a credit card withdrawal service, which might occur if the credit card data is invalid or expired. Another example is the loss of a package by a package shipping service. Considered failures are handled in ASG by conducting re-planning. In case a considered failure occurs during the invocation of a service, the Planning Sub-cycle is triggered to find a new composition. Referencing to the package shipping service example, this might mean that a new package is seized and send. Naturally not all considered failures can be handled by re-composition. In the case of the credit card withdrawal service example, a recovery is not possible and it is even not desired if a credit card is turned out as being invalid.

In contrast to the considered, are the unconsidered failures not explicitly specified in the service specifications. Unconsidered failures are usually low-level issues like network failures which are raised pre or during the invocation of a service. The platform has no detailed information about semantic effects of such failures except that these failures just happen at a given point in time. For this reason it assumes in such cases of failure, that the according service simply has not been executed and thus its desired results and effects are not achieved. Such unconsidered failures are handled in up to two phases. In the first phase the platform tries to recover the failure by re-binding. This triggers a new pass of the Binding Sub-cycle. A search for an alternative equivalent service to the already invoked and failed service is conducted by negotiation with or selection of proper services. If the search is successful, the new service is invoked as substitution for the old one. Else the second phase is conducted. In this second phase the ASG platform tries to recover the unconsidered failure by re-planning the composition in the Planning Sub-cycle. In case this planning is successful the Binding Sub-cycle is invoked. After the outstanding service placeholders have been bound to concrete services the new composition is enacted in the Enactment Sub-cycle.

The key results of the ASG project on a high level of granularity and abstraction are:

1. Semantic Service Provisioning Architecture

   The ASG project developed a reference architecture and blueprint for semantic service provisioning platforms. Major features of an ASG-compliant platform are summarized as the ASG Service Provisioning Features. For testing and evaluation purposes a reference implementation of a semantic service provisioning platform (known as the ASG platform) is provided. For the design of the architecture and implementation of the ASG platform following approaches and technologies have been scientifically and practically elaborated and integrated:

   - Web Service Modelling Language (WSML) as ontology language, Web Service Modelling Ontology (WSMO) as semantic service description framework, and a F-Logic-based reasoning engine
   - Automated service matchmaking and composition using reasoning and planning techniques
   - Selection of services in consideration of quality of service execution aspects by supporting both: simple and advanced agent-based negotiation approaches
   - Business Process Execution Language (BPEL) compliant enactment of service compositions, dynamic profiling of services
   - Web Services Resource Framework (WSRF) based integration of stateful real-world services; dynamic service hosting, execution and monitoring on heterogeneous execution resources and platforms

2. Service Integration and Development Tool-Chain and Methodologies

   To provide systematic and easy-to-use support for development and tailoring of external services with the ASG platform, our project provides service integration and development methodologies. Furthermore a prototype of an integration tool chain is supplied to raise applicability of the methodologies. In addition the tool chain facilitates mechanisms for supporting development of ASG-compliant services by dynamically generating new services from service templates according to given semantic service specifications. Following techniques and approaches have been exploited to provide this key result:

   - Development tools supporting generation of proxies for external Web services and semi-automatic semantic description of Web services
   - A XML-based Service Language to describe the mapping of data types
   - Tools enabling development of service families supported by feature modelling mechanisms
   - ASG development processes are based on the ISO/IEC12207 "Information Technology – Software Life Cycle Processes" and ISO/IEC 15504 "Information Technology – Software Process Assessment" standards and have been refined and stabilized based on feedback from developers
   - ASG development processes are exchanged in the project using Electronic Process Guides (EPG)
   - Application and service engineering use Unified Modelling Language (UML) 2.0 to model and document ASG services and ASG service-based applications

- The service model seamlessly integrates two service specification languages, Web Services Description Language (WSDL) and Web Service Modelling Language (WSML), as well as approaches for component-based software engineering

3. Business scenarios for Semantic Services

   For evaluation and the preparation of practical application of the ASG architecture, reference platform, tool chain and methodologies business scenarios have been developed. Two of these scenarios, namely the "Attraction Booking" and the "Dynamic Supply Chain" scenario have been implemented on basis of the ASG platform to provide more detailed experiences. Following artefacts have been elaborated within this result:

   - Business scenarios exploiting the features of an ASG compliant service provisioning platform
   - Technical implementation of relevant features in two business scenarios
   - Knowledge transfer to and set up of exploitation plans for industrial partners
   - Evaluation of costs and business benefits of ASG compliant semantic service provision

Furthermore: A multi-media introduction to ASG can be found at to following web page: http://asg-platform.org/cgi-bin/twiki/view/Public/ASGAnimation

2.3 Project Impact and Exploitation

by Dominik Kuropka, Ralf Hinz, Jörg Bartholdt, Mariusz Momotko, Guido Laures, HolgerKrause

As a result of the separate work component Dissemination an significant impact in industry and science is reached, exemplarily named shall be response in the press and magazines, influence in European and national clusters and networking, events of information exchange as scientific conference tracks and industry-oriented workshops, lectures as tutorials and hand-on sessions, and finally demonstrations of tools and platform prototype. Around 120 persons joined scientific conference tracks and sessions of ASG, around 160 have been interested in industry-oriented workshops, over 200 persons were guests of tutorials, hand-on sessions and demonstrations and nearly 50 persons get in contact with the ASG-PhD-programme.

After 2½ years of project work, the ASG-consortium is able to fulfil the requests for disseminating ASG key features and knowledge by prepared scientific material, set of ASG tutorials, hands-on-sessions, prototypical demonstration scenario, online-knowledge base and the exploitation oriented website. The dialogue with potential users has been used for refinement of R&D work as well as for adjustment of dissemination activities and will be continued after the project. (Please refer also to the component flyer “Lessons learned”).

Detailed exploitation strategies for the project key results are presented in two ways: for the general business on European level in the ASG White Paper (M30) and for the single ASG-partner in the “Exploitation Plans of Partners”, initially released as Part B in the D7.IV-deliverable (M24) and updated as Appendix of the “M30-Plan Using and Disseminating Knowledge” (exception: DC-Exploitation Plan are ASG/EU only). Therefore we want outline here only the most important parts of our exploitation strategy from which we expect the highest impact on industry and science:

- The Hasso Plattner Institut (HPI) started a new project with the T-Systems Enterprise Services GmbH who is not a member of the ASG project. In this new project the ASG platform is adapted to information Web services provided by the T-Systems Enterprise

Services GmbH. The aim of this project is to test how an implementation of an ASG-based system can provide benefits for the company and raise the efficiency of their service provision.

- There are two main types of results achieved by ASG which are exploited by Rodan: The first type of results is related to extensions (e.g. process re-planning, unified invocation of atomic services, monitoring of Quality of Service, and visualisation of service enactment) of functionality provided in OfficeObjects® WorkFlow engine, an OfficeObjects® product to support business process management and workflow management. The second type of results is related to new concepts and frameworks that are likely to be implemented in the future versions of Rodan's products. This includes various execution strategies for adaptive service compositions which have been elaborated in the project.
- As an e-commerce service provider operating on a worldwide scale, Hanival wants to gain essential market-shares in the ISP and service market. A vital role in Hanival's expansion and business opportunities is played by the level of automation and integration of third party services reached in the next year. As main results from the ASG project, it is expected to introduce semantic composition and integration solutions for Hanival's e-commerce, customer care and billing systems that provide a higher level of automation and a dynamic way to compose and integrate external and internal services, based on the semantic service description.
- Siemens will use the results of ASG in the fields Architecture, Methodology and Testing to improve upcoming SOA projects, enabling faster time-to-market and higher quality software products. At Siemens Building Technologies, generation of artefacts is driven by the experiences (in the context of OpenXL and SLL) made in service generation (C-3). A potential candidate is SmartHome, a Siemens Business Unit project, where we applied some ASG techniques to the SmartHome demonstrator, that proved valuable for the flexible creation of service environments.
- In the context of automobiles, the provision of services for mobile uses was in the past not really successful due to the lack of flexibility of traditional, monolithic service provisioning approaches. DaimlerChrysler research sees the flexible and dynamic approaches developed in the ASG project as potential candidates for future mobile service provisioning platforms.
- Software AG is not a member of the ASG project, nevertheless are results of the ASG project exploited by Software AG through a formalized cooperation contract between the HPI and the Software AG. The cooperation includes a prototypical integration of ASG components and approaches for semantic-enabled service matchmaking and composition into Software AG's product line *Crossvision*.
- To foster the reuse of project results in industry and academia major parts of the software developed in the project will be published under an open source licence (LGPL) after the last formal review on the project homepage. Additionally an installable demonstrator will be prepared and published, which includes all open source parts and the OfficeObjects® WorkFlow engine for demonstration purposes.[1]
- Major project results are disseminated to the public by multiple book contributions and a highly-requested tutorial on Web service standards interoperability. Former

[1] We are thankful to Rodan for the generous donation of their OfficeObjects® WorkFlow engine for the ASG demonstration purposes.

colleagues from the C-5 work component meanwhile use their ASG knowledge in a newly founded German start-up company Mindquarry[2].

- Finally a part of the project participants are working on a book and they will continue working even after the end of the project. The aim of this book is to aggregate and consolidate all results of the project in one unified work. The book title will be "Semantic Service Provisioning" and it will be published by Springer with the beginning of 2008.

3 PROJECT CONSORTIUM INFORMATION

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