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A Service Architecture for semantic aware Mobile Services

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***Abstract*— Several standards for Service Oriented (SOA), supported by tools and methodologies are under development. The Adaptive Service Grid (ASG) project develops an advanced SOA compliant service platform in order to fulfil the needs of services in range of service domains, e.g. Telematics, Telecommunications, eGovernment and Enterprise IT. Platform development is well under way, supporting semantic specification, registration, discovery, composition and enactment of composed and atomic services. Especially the domain of Telematics or ITS will require wireless terminals that connects users to the applications in the fixed network.**

***Index Terms*—Adaptive Service Grid (ASG), SOA, Intelligent Transport Systems (ITS), Telematics, Semantic Aware Mobile Services**

INTRODUCTION

To develop and maintain services for the future that are both attractive, easy to use and cheap enough it is realized by the developers that new methodologies, techniques and tools are necessary. Based on these facts have concepts and technologies like Service Oriented Architectures (SOA), Web Services (WS), Semantic Web (SW) and Semantic Web Services (SWS) gradually grown up to show their viability, especially if they are used in combination.

Ongoing work in standardization bodies (e.g. W3C and OASIS) and research forums (e.g. EU IST FP 6) supports these developments. The ASG (Adaptive Service Grid) project is a typical example of an EU project that has as its goal to utilizing concepts and technologies from SOA, WS, SW and SWS demonstrate their maturity by developing services within selected business domains. Telematics is one of the four domains that ASG is focusing on.

Originally, the term Telematics derived from an integration of the terms Telecommunication and Informatics, today more often known as ICT (Information and Communications Technology). The term Telematics is today more commonly narrowed down to mean Intelligent Transportation System (ITS), i.e. an ICT system dealing intelligently with everything related to transportation such as vehicles, roads, public transportation, travel information, traffic management, traffic emergency, etc.

The main purpose of this paper is to establish a roadmap for Telematics Services based upon concepts of SOA, WS, SW, SWS, enhanced by ASG concepts.

Service Oriented Architecture

The history of evolution of SOA has been quite long. It has its roots back to the 1980's when the Object Oriented paradigm emerged and early 1990's when the first commercial use of the Web started. Distributed component models (DECOM) and commercial component based architectures (Corba) paved the way for the Web Service in the late 1990's [4].

A SOA Framework

SOA as a vision evolved well, but different implementations hampered the applicability. To avoid those problems OASIS established a framework and drafted a Reference Model that a system has to adopt in order to claim compliance with the OASIS SOA specifications [1].

According to the OASIS framework SOA is an architectural paradigm (model) that does not necessarily mean usage of Web Services although Web Service is a popular implementation. The SOA RM should captures core principles and axioms of SOA and be used as a template for the SOA architecture [2,3].

Telematics scenario and Requirements

The Telematics scenario presents a location based mobile service within transportation. The goal of the Telematics service is to provide customers with any information on her/his mobile phone that might be of interest while commuting by car to work or visiting an unfamiliar area, for example as a tourist. In the commuting situation, the goal is to improve travel efficiency by the support of route planning and rescheduling based on information on the traffic situation, road conditions, public communication, parking area locations, etc.

These services are also useful in a tourist situation, but with the additional goal of improving the experience of the visited area. This can be information about the cause of a traffic incident, estimated delay, alternative routs, etc. Further information can be about points of interest (POIs), such as opening hours, route description, etc.

The customer coordinates combined with information about the user’s route, the traffic conditions on alternative routs, traffic forecasts based on traffic history, user preferences, public transportation, etc. can then be utilised to sort out the relevant incidents in the traffic and propose best-effort action for the user. The Traffic Incident Service alerts the traveller about major incidents that is likely to influence the planned journey, using the customer’s coordinates, direction and route information, in combination with the coordinates and expected delay caused by the traffic incident.

Semantic Functionality Requirements

The analysis of all scenarios led to 7 business requirements for service delivery:

Reuse of existing functionality, e.g. services and infrastructure, makes use cases cost-efficient to realise.

Standards and Reliability are essential for industry to adopt solutions.

Openness will allow integration of additional services with as little changes as possible.

Adaptivity to current environmental constraints, e.g. user preferences and user connectivity is key for user acceptance of new services.

Dynamic and transparent service composition is required to adapt to the specific service requests.

QoS awareness handles specific user requests, e.g. budget or time constraints.

Semantic Awareness is crucial for understanding the user request, service discovery and service composition.

These requirements are taken into account when defining the ASG platform.

SOA and ASG

Since OASIS and W3C are the major standardisation bodies within this field, their specifications and standards are quickly adopted by the majority of the software vendors and developers. In this chapter we will compare the SOA defined by OASIS to ASG and highlight the similarities and differences.

The ASG Model and Architecture

The ASG Architecture and Implementation are developed independent of the OASIS specifications [5]. However, since both are established on the common worldwide knowledge base about SOA they have more similarities than dissimilarities. Neglecting differences in terminology, it might be basis for the allegation that ASG partly is an advanced OASIS SOA compliant system.

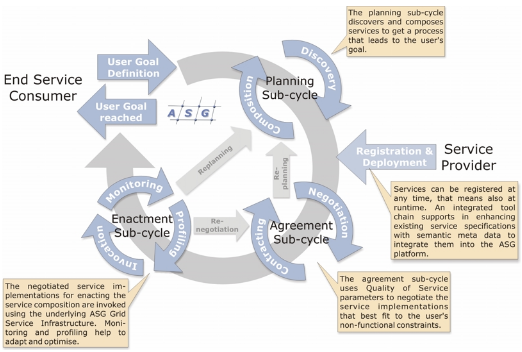

Figure 1 - ASG reference model

The ASG Reference Model (figure 1, [5]) follows basic concepts, complies with the OASIS RM and extends its functionality:

- *Façade*: It serves as an entry point to all external usable functions of an ASG reference architecture implementation and is remotely accessible Service Providers and Consumers.

Comply with the extended OASIS RM.

- *Composition*: This is an automated service composition according to a specified goal.

*Complies with the **use of the OASIS RM Service** and **Data Model** concepts.*

- *Discovery:* It provides functionality to store, retrieve and delete semantic service specifications, service grounding specifications, composed services and ontologies.

*Complies with the Service Client **usage of the OASIS RM Advertising** and **Service Description** concepts.*

- *Negotiation:* It provides functionality responsible to select appropriate service implementations (groundings) with respect to Quality of Service (QoS) parameters, which are defined in the user request that should be used inside a service composition.

*This is a more advanced concept compared to use of the OASIS RM **Contract** concept (**partly included**).*

- *Contracting:* It provides functionality used to mange the contracts between the parties that are involved in a service usage scenario.

*Fully compliant with the OASIS **RM contract** concept.*

- *Invocation:* It provides standardized interfaces to instantiate and to invoke atomic services. It abstracts and encapsulates possible heterogeneous service hosting and runtime environments of the underlying ASG Infrastructure, e.g. a Grid infrastructure. A major responsibility is the late and adaptive binding of resources in the ASG infrastructure to execute atomic service implementations enabling efficient load balancing and reliable service provisioning.

*This concept is partly overlapping with the **Service Provider's offering in OASIS SOA RM, but adds** advanced capabilities compared to plain service offering (**partly included**).*

- *Profiling*: It provides functionality responsible for collecting history data and building service profile that can be used during negotiation process. It offers functionality to dynamically log and retrieve service enactment behaviour characteristics like response time, reliability, functional correctness, etc

*This is an **additional concept** compared to the OASIS RM.*

- *Monitoring:* It provides functionality to monitor service instance invocation characteristics. Examples of monitoring attributes are performance (response time) or costs. The offered monitoring information is used to dynamically identify eventually broken Service Level Agreements (SLAs) or unreachable services, which would trigger an adaptive re-planning of the composed service.

*This is an **additional concept** compared to the OASIS RM.*

In addition to the basic concepts the ASG Reference Model define three groups that consist of basic concepts that cooperate to complete a defined sub-cycle in the complete cycle in the process of offer a service to the End Service Consumer:

- ***Planning:*** This sub-cycle comprises the *Discovery and Composition* that together provide the functionality responsible for finding a way to deliver a requested service and do the re-planning after a failure during enactment that could not be compensated by renegotiation.

- ***Agreement:*** This sub-cycle comprises the *Negotiation and Contracting* that together tries to obtain the best match to the Quality of Service required by the Consumer.

- ***Enactment**:* This sub-cycle comprises the *Invocation, Monitoring and Profiling* concepts that together provide the functionality that handles the full enactment life-cycle of a service composition and plays a central role in service delivery of ASG reference architecture.

ASG extensions of basic SOA

ASG complies with OASIS RM, and provides additional functionality that makes ASG more advanced compared to more traditional SOA systems. Table 1 gives a simple overview of the similarities and dissimilarities between ASG and a traditional OASIS SOA compliant system.

Table 1 Comparison between OASIS SOA and ASG

ASG	***OASIS SOA (RM)***	***Comments***
Facade	*Included*	See extended RM
Composition	*Included*	Use of RM ***Service*** and ***Data Model***
Discover	*Included*	Use of RM ***Advertising*** and ***Service Description***
Negotiation	*Partly included*	Use of RM ***Contract***, but ASG more advanced
Contracting	*Included*	Creation of RM ***Contract***
Invocation	*Partly included*	Use of RM ***Service Offer***, but ASG more advanced
Monitoring	*Not incl.*	New advanced concept in ASG
Profiling	*Not incl.*	New advanced concept in ASG

The comparison between the OASIS RM and the ASG concept shows that ASG is true OASIS SOA Compliant system with respect to concepts and functionalities. However, ASG adds some advanced concepts that are not yet considered by the standardisation bodies.

In spite of the big conformity it is a great chance that interoperability problems will occur between an ASG system and an OASIS compliant SOA system. The reason is the choice of different semantic standards for describing their respective data models. OASIS is using the W3C semantic standards (XML, RDF, OWL, etc., while ASG use Web Service Modelling Framework (WSMO).

Applying ASG to Telematics

In this chapter we will give an overview of how to make a new ASG (a SOA compliant system) services in general and ASG based Telematics services specially.

When starting to realise a SOA system and services it is recommended to choose a well defined method supporting the promised capabilities of SOA. In the method used by ASG is the Use Case Definition that defines the use case in a scenario within your service domain, e.g. a commuter in the Telematics domain (see figure 2).

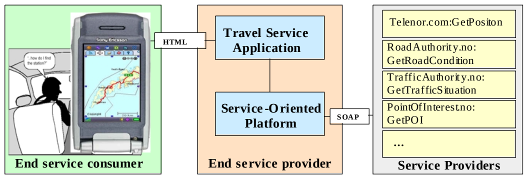

Figure 2 - Telematics scenario, with actors and use cases

The most important task is the Use Case Definition (figure 3) that defines the use case in a scenario within your service domain, e.g. a commuter in the Telematics domain.

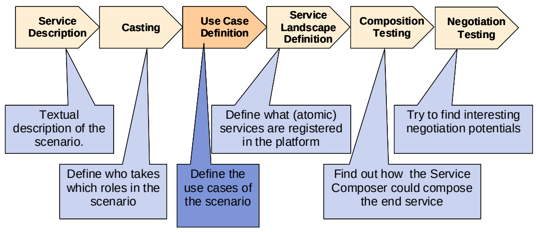

Figure 3 - ASG scenario mapping

Our scenario describes the commuter (or tourist), who expects dynamic information about traveling (see figure 2).

The goal of the design process is to provide service developers with information required to establish their services through the ASG platform. For Telematics, the design contains:

The Scenario Description defines the overall scenario. The list of stakeholders contains companies interested in supplying services to the end-user, as such: Mobile operators and location providers, Payment operators, Points-of-Interest providers as e.g. tourist offices, lodging providers, guiding and sightseeing providers, Encyclopaedia and travel guide providers. Car/traffic related providers are gas and service stations, road authorities, radio broadcasters, traffic and weather forecasts. Thus, a potentially wide spread of service providers is willing to provide services for the travelling user.

The Application flow describes the user interaction flow in sketches for the user diagram and as an application flow diagram, and is detailed in Use Cases descriptions (see figure 4 as example).

The Telematics environment with potential stakeholders listed previously covers a wide Service Landscape. This service landscape, a list of atomic services, is too complex to be composed to end-user services in a conventional platform. Service Composition is required identify and describe the possible types of service compositions based on the semantics and services from the service landscape.

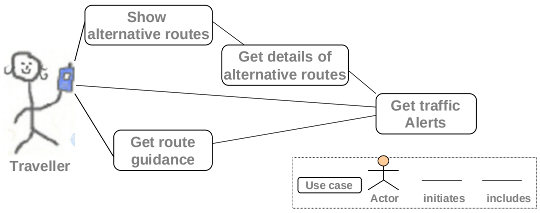

Figure 4 - Use case alternative route description

Roadmap for Telematics Services

The availability of open Telematics services in the future will depend highly on two parallel developments: The industry uptakes of SOA and the standardization of the telecommunication Web Service (Parley-X/3GPP OSA), including semantics for Telematics data (figure 5).

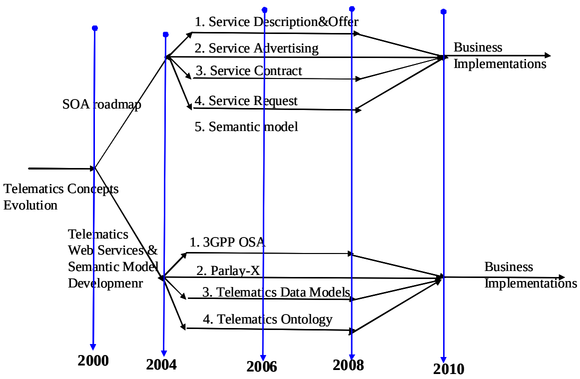

Figure 5 – Roadmap to Semantic-based Telematics Services

In ASG ongoing platform and prototype service developments show that prototype development is well under way, and tools are expected to reach the developer market within mid 2006 (figure 6). More crucial are domain ontologies, standardisation, and the service inclusion through existing platforms, expected to happen until 2008. Substantial market penetration will then follow in the years afterwards.

Compatibility issues

In theory, all OASIS SOA implementation have a core of common features defined by SOA RM. However, it is a great chance that many of the SOA implementations from different vendors still are incompatible and difficult to combine, e.g. use of different standards – functional as well as semantically. This problem is raised and tried solved in the OASIS Electronic Business Service Oriented Architecture (ebSOA) Technical Committee (TC) [7] [8].

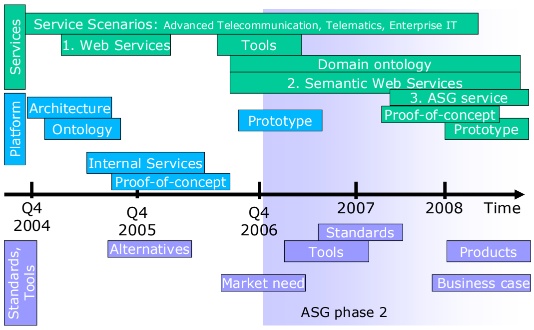

Figure 6 – Roadmap for ASG based services

Even more challenging will it be to solve the requirements for mobile usage of enterprise applications based on SOA technology, addressed by the reference architecture from SAP and Intel (figure 7) [9].

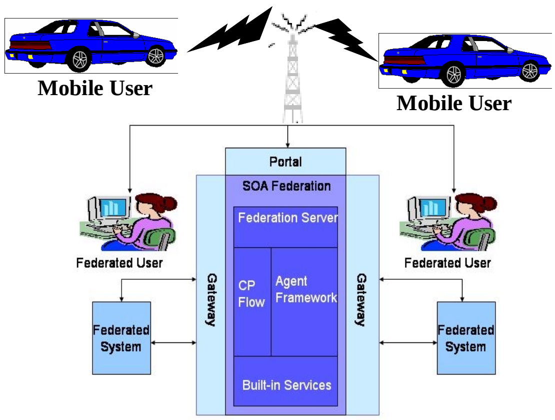

Figure 7 - Federated Environment Reference Architecture of SOA Implementations with Mobile Users

Mobile solutions of SOA based applications

The architecture shown in Figure 7 is generic and may probably work fine for both office and mobile workers. However, this assumes the same capabilities in a mobile environment as in a fixed one. In real life we know this is not true. Mobile environments are characterised with e.g. „not–always-on" network connection, limited bandwidth, tiny wireless devices with limited processing power and display, etc. The first generation of mobile business solutions did not take all those limitations serious enough and overestimated the promise of the „always-on“ and „broad-band“ capabilities of the new wireless networks, such as GPRS, EDGE and UMTS.

Our suggestion is to start from an ever changing user context and an only occasional connection to a reliable network. A mobile application can not rely on data exchanged in real-time when needed since the client and service parts are often disconnected from each other. To work in a shifting connected/disconnected environment it is important that the application has precisely enough functionality to meet the needs of its users to complete the part of the application process that is mobile.

The problems mentioned above can be solved by provisioning of Mobile Built-in-Services (MBiS) in the SOA Federation component. MBiS should manage seamless exchange of data between the client-side and server-side. It must reach into the enterprise application and create a live copy of the data needed to support the part of the application being moved to the device. For example, if the mobile device is used to collect transaction data for the enterprise application, such as creating a sales order, then all of the information needed from the user must be collected and transmitted back to the server. The MBiS then creates and executes the transaction by synchronizing its copy of the new exchanged data that are forwarded to the original back-end application, and thus creating the new sales order.

Acknowledgement

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Erik Lillevold is former Senior Researcher at Telenor R&D with more and 30 years of experience in different fields within Computer and Communication Science. From 1971 – 1986 he was a research scientist at NDRE (Norwegian Defense Research Establishment) working with different kind of computer communication projects. NDRE has close relation to US DoD. Therefore he become early involved in the DARPANET (later Internet) project (1974) ending with a stay as International Fellow at SRI, Menlo Park, California (1981). Lillevold was later on involved in ISO and CCITT standardization of the MHS (Message Handling System) developed by CCITT and specified in the X.400 Recommendations.

In ASG he focuses on Web Services and Agent Technology, in addition to telecom systems.