

# ROADMAP TO ASG BASED SEMANTIC WEB SERVICES

Josef Noll<sup>1,2</sup>, Erik Lillevold<sup>2</sup>

<sup>1</sup>Telenor R&D, N-1331 Fornebu, Norway, <sup>2</sup>UniK, N-2027 Kjeller, Norway  
<sup>1</sup>josef.noll@unik.no, <sup>2</sup>erlille@online.no

**Abstract.** Several standards for Semantic Web Services (SWS), supported by tools and methodologies are under development. The Adaptive Grid Services (ASG) project develops a semantic Web service platform in order to fulfil the needs of 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.

Business in SWS delivery will be based on extensions of existing infrastructure, thus a roadmap for evolution is of crucial importance for business development. The roadmap covers the major items: standardisation, platform development, service scenario, and SWS business. Based on an example in the Telematics domain, this paper shows that prototype development is well under way, and tools are expected to reach the developer market within mid 2006. More crucial are domain ontologies, standardisation, and the service inclusion through existing platforms, expected to happen until 2008. Substantial market penetration will then follow.

## 1. 1. 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 standardisation 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 a EU project that has as its goal to utilising concepts and technologies from SOA, WS, SW and SWS

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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, and SWS, enhanced by ASG concepts.

## 1.1. 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].

### 1.1.1. 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 capture core principles and axioms of SOA and be used as a template for the SOA architecture[2][3].

## 2. Scenarios and Requirements

In order to establish requirements for future services platforms four scenarios were selected, and each of them used to validate the suitability of an ASG based service execution [6]. The scenarios cover:

- Telematics, commuter and tourist use cases

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- Dynamic ESP supply chain (as part of a Telecom scenario)
- Service Monitoring (as part of an Enterprise scenario), and
- Document discovery (as part of an e-Government scenario).

This paper will use the Telematics scenario.

## **2.1. Telematics Scenario**

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 utilized to sort out the relevant incidents in the traffic and propose best-effort action for the user. The Traffic Incident Service alerts the traveler 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.

## **2.2. Semantic Functionality Requirements**

Analysing the 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.

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*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.

### 3. 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.

#### 3.1. SOA Reference Model (RM)

As already stated is the SOA RM not an architecture for a single SOA system, but a model for a range of Service Oriented Architectures and thereby a guide for analysis and comparison. It is based on a small number of unifying concepts of all SOA's and gives a framework for understanding significant relationships among the entities in a SOA environment.

Only the Core RM is normative, which all SOA's must comply with [1]. However, the Core RM may be enhanced with some extensions, which are not normative but help to make the RM more useful. Figure 2 shows the Core RM enhanced with the concepts of Service Provider and Service Consumer.

In the Core RM is following concepts defined:

- *Service*: A service is a contractually defined behaviour that can be implemented and provided by a component for use by any component solely based on the contract.
- *Service Description*: Technical parameters, constraints, policies that come together to define terms of invocation
- *Advertising*: Service must somehow communicate its service descriptions in a manner that is accessible to potential consumers.

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- *Data Model*: The specification and constraints imposed on instance data within a Service Oriented Architecture environment.
- *Contract*: The implicit or explicit bi-lateral or multi-lateral agreement between the owners or agents of a service and those who use the service.

### 3.2. 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.

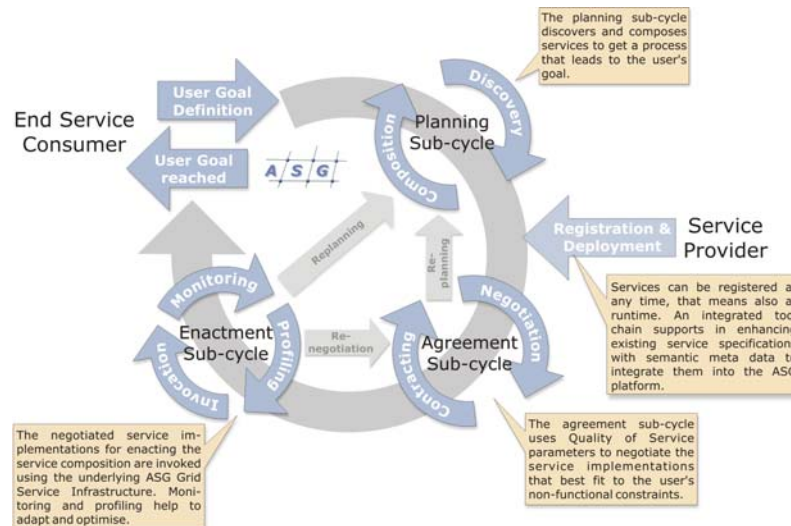


Figure 1 ASG reference model

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 manage 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.

### 3.3. 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.

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

**Table 1** Comparison between OASIS SOA and ASG

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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).

## 4. Applying ASG to Telematics

One of the major motives for an enterprise to consider using SOA is how to reuse their existing IT investments. The core components of ASG and other SOA operating environment are integration and infrastructure management. Integration enables an efficient and flexible combination of resources to optimize operations across and beyond the enterprise. It's all about how to connect people, processes and information. Infrastructure management addresses how to reduce management complexity and thereby make better use of assets, improve availability and resiliency and reduce costs.

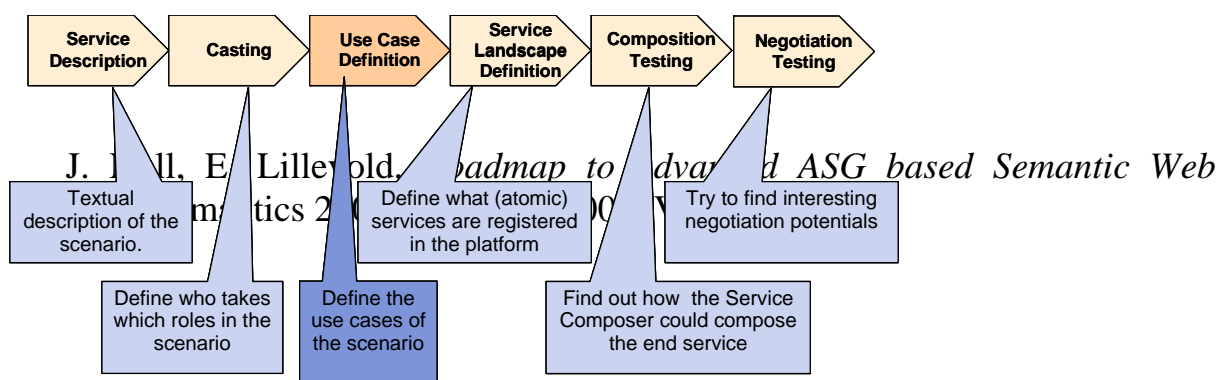
The properties of a SOA environment makes it very attractive as an environment for Telematics services, i.e. information and communication services about all kinds of transportation means such as vehicles, roads, public transportation, travel information, traffic management, traffic emergency.

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.

### 4.1. Scenario to Architecture mapping

When starting to realise a SOA system and services it is recommended to choose a well-defined method supporting the promised capabilities of SOA. The method used by ASG is shown in Figure 2.

The most important task 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.

Figure 2 ASG scenario mapping

## 4.2. Use Cases and Business

Figure 3 provides the use cases for the Telematics scenario, introduced in section 2.1. It describes the commuter (or tourist), who expects dynamic information about travelling.

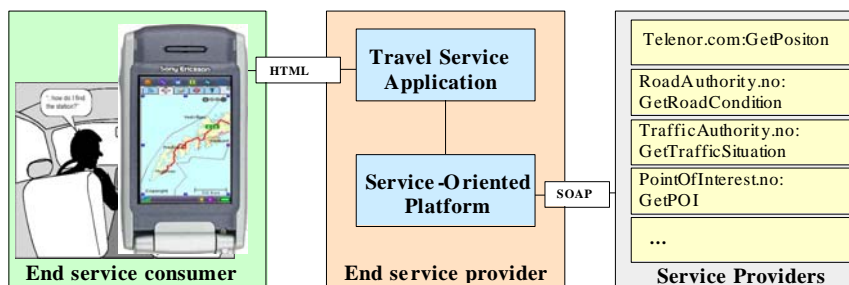


Figure 3 Telematics scenario, with actors and use cases

The service should be available on the mobile phone or the car information system, and should include all relevant sources of information from service providers: Internet, broadcast, car navigation systems, and mobile platforms.

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, and is outlined earlier in section 2.1. 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.

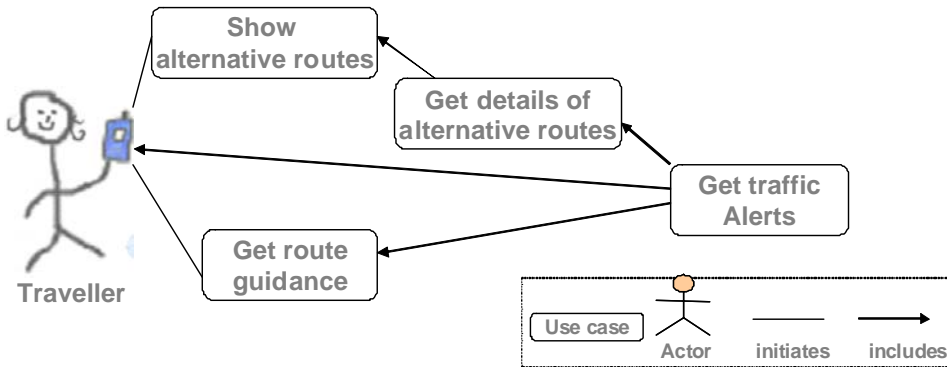


Figure 4 Use case alternative route description

## 5. Roadmap

From an industrial point of view, a roadmap should provide information about the expected time to market for a certain technology. It should cover the major items:

*Standardisation* is required in order to establish a new service generation, here: Semantic Web Services. Telecom operators as the likely owners of semantic service platforms need to make services future proof.

Experiences from *platform development* are used from operators to define their technology strategy, thus deciding when to move towards a new technology.

*Service Development* of prototype services will be used to experience the complexity, and thus establish knowledge on the requirements for mass-market end-user services.

The *Business rollout* will require professional tools for ontology and service developments. First when the infrastructure is in place, market expectations and business cases can be performed for a specific set of envisaged rollout services.

The following chapter provides estimates on these items, based on the experiences from scenario design and prototype development in ASG.

## 5.1. ASG Developments

The roadmap for ASG based services covers the major items identified earlier. Estimations for the roadmap are provided in Figure 5.

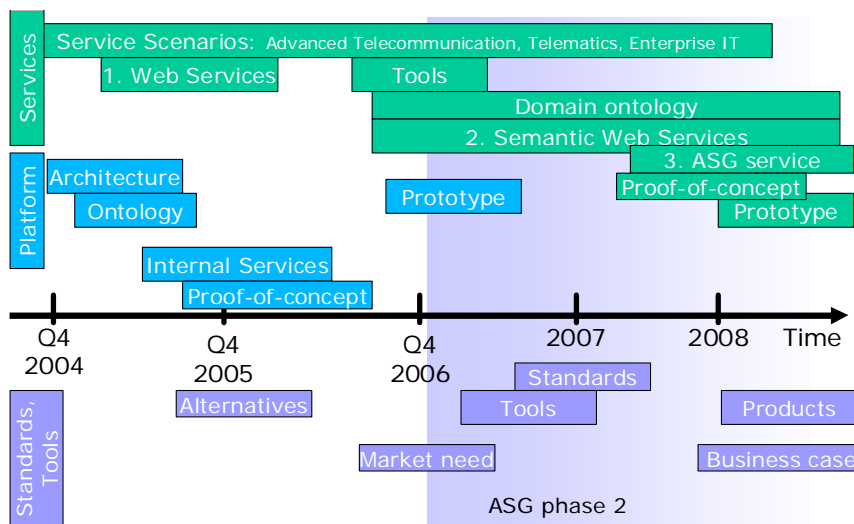


Figure 5 Roadmap for ASG based services

For ASG based semantic services, prototype development is well under way. First demonstrations of platform functionality have been presented in Q3.2005. Tools for ontology developments in WSMO have currently been prototyped and are expected to reach the developer market within mid 2006. More crucial are domain ontologies, standardisation, and the service inclusion through existing platforms. Only preliminary actions have started, and suggest that domain ontologies for prototype services will be available by mid 2007. Standardisation is expected to happen until 2008. Substantial market penetration will then follow in the years afterwards. A more detailed discussion specifically for Telematics services is provided in the next section.

## 5.2. Semantic-based Telematics Services

A newly published survey by AMR Research about adoption of SOA concepts and technology in real business systems unveil that quite many early adopters using parts of SOA already or are planning to starting investments in SOA in the near future [4]. The trend toward SOA and implicit semantic based services seems obvious. However, how and when the SOA will be adopted by

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the market is not easy to foresee. Based on our experiences with ASG and the work in 3GPP, we expect a standardisation and development roadmap to semantic-based Telematics services to follow the timeline indicated in figure 6.

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

The SOA roadmap will rely on standardisation and research several basic functional components. Service Description and how they are offered through standard interfaces will obviously rely on soon mature Web Service standards. Service Advertising and Negotiation is an area where research work is still needed before it becomes fully automated. The same is also true for Contracting and Service Level Agreement. It is still not agreed among SOA developers, which Semantic Model is best. Many seem to adopt the W3C model (XML, RDF, OWL, etc), while others are testing alternatives. ASG seems to decide to use WSMO that probably is one of the strongest alternatives to W3C.

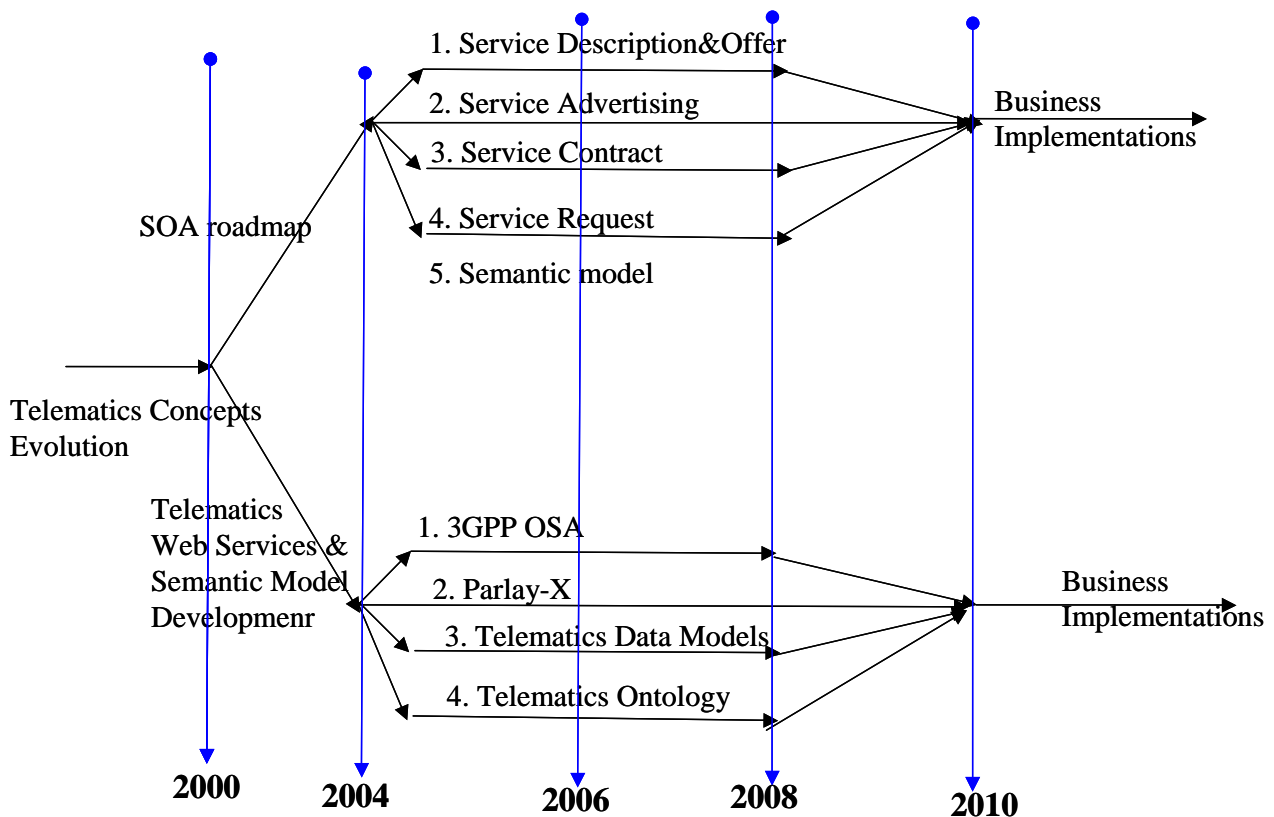


Figure 6 Roadmap to Semantic-based Telematics Services

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At the Telematics (telecommunication and semantics) branch of the roadmap, are 3GPP and Parley almost reaching the business acceptance of standardising a large set of Telecom Web Services (Parley-X). The work to make semantics and ontologies for Telematics data is under way through several Telematics research experiments, but still not mature. The Open Geospatial Consortium (OGC), an international organization with more than 280 members, has among others developed the Geography Markup Language (GML). It utilises XML to express geographical features and can serve as a modelling language for geographic systems as well as an open interchange format for geographic data, which might influence development in the location-based service world.

To foresee a precise time-line for business implementations of semantic-based Telematics services is not easy. However, based on the work in ASG and standardisation bodies we believe that the first few SOA-/Semantic-based Telematics services are available on the market in a time frame of 3-5 years.

## 6. Conclusions

This paper presents the ongoing developments in the Adaptive Services Grid (ASG) project, the ASG platform, and ASG based services. Four scenarios in Telecommunications, Telematics, IT-industry and eGovernment have been used to establish the 7 business requirements for a future service platform.

ASG fulfils the requirements, and extends the specifications of the OASIS SOA Reference Model (RM). In spite of the big conformity to the RM 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.

Based on an example in the Telematics domain, the design specifications for advanced services are outlined. The business potential is addressed through an analysis of end-user services. Roles of stakeholders are identified, and their atomic services put together to value-added end-customer services.

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. 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.

## 7. References

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