Estimating business profitability of Semantic Web Services for Mobile Users

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Abstract. *This paper addresses the business of semantic based service delivery of advanced services for the mobile user, using roaming of location information as an example. Telecom networks provide voice and data connectivity in other countries, but advanced service roaming as e.g. location is not yet in place. This paper highlights the complexity of location services, indicating both technical and sociological challenges for this type of service, and proposes WSMO based semantic annotations as a possible way of overcoming existing limitations. The paper shows how our proposal is applied to a real use case seamless access to the Orange and Telenor location services. Based on the experiences gained the authors provide business expectations of semantic web services for the mobile user.*

1. Introduction

This paper addresses roaming of advanced communication services. Basic communication services like mobile telephony and SMS became popular, because customers do not have to configure the devices. The services are available everywhere due to seamless service set-up and roaming agreements.

Future services will need more than just connectivity. Positioning, tracking, and seamless service access to personalized services are already demonstrated in various environments [1]. Main focus is on adaptation towards the user terminal, which typically is the mobile phone. In upcoming world of pervasive services the user will be surrounded by a variety of devices, e.g. smart tags, smart assistants, wearable communication. These devices will communicate to the user and his personal devices, and will address network services.

With the evolution towards a new way of computing that of service orientation, seamless integration of heterogeneous external services has become critical. This is especially true in the Telecom industry, where different Telecom providers look for means of integrating their heterogeneous external services. Roaming of connectivity for GSM, GPRS and UMTS is in place, but the current infrastructure does not support roaming of advanced services such as location information.

Semantic Web-based technologies are widely acknowledged to play an important role in solving the interoperability problem between applications; the usage of semantic description in the context of

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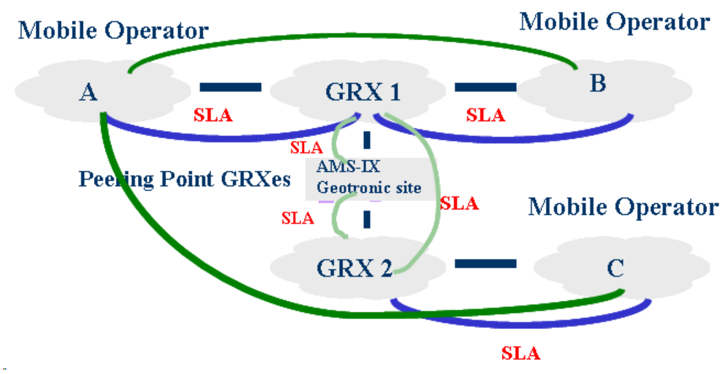

Figure 1. Complexity of providing QoS in a roaming scenario [3]

advanced Telecom services is expected to support easy access to the services. Not only such formal and explicit descriptions enable easy service integration, but also support service roaming across networks and countries. Based on the semantically enhanced service description of location based services, one will be able to deduct general service ontology for that type of service. This will enable interoperability between different Telecom providers and other location service providers.

The paper takes roaming of location information as a basis for the estimation of effort used to describe these services in a semantic web service architecture. Section 2 states in more details the problem of roaming of advanced Telecom services, Section 3 discusses the benefits of semantic annotations in the context of the Orange and Telenor location services, Section 4 analyses the business profitability of semantic based services and Section 5 concludes the paper.

2. Advanced service roaming

Roaming is a key issue in Telecom service provision, and was first enabled in Europe through the GSM mobile telephony service. 3G was introduced to provide roaming on a worldwide base, and compatible standards as UMTS are currently rolled out in the whole world. Systems beyond 3G will provide personalized wireless broadband access, and will incorporate mobile and wireless access methods including e.g. Wifi, WiMAX [?]. Offering personalized broadband wireless services across networks, both national and international, will require new ways of service interconnectivity.

2.1. Mobile Service Roaming

GSM service roaming is based on a bi-lateral agreement, and is technically spoken an easy service provision. GSM packet data (GPRS) roaming is technically also easy to realise, and was demonstrated in November 2000 between Telenor (N) and Sonofon (DK), based on GSM roaming exchanges (GRX) [3]. The current set-up provides data connectivity on a *best effort basis* (see Fig. 1). To provide end-to-end QoS is a challenge, as it would require the description of service capabilities and the negotiation of these capabilities. The packet data QoS description covers 7 classes, each of them with a varying number of subclasses. A negotiation of all the potential combinations in a roaming situation is too costly, and thus not implemented.

As QoS is an end-to-end measure, it needs service level agreements (SLA) between each mobile operator and the corresponding GRX, as well as SLAs between all GRX. The future service world will include requirements for QoS measures, but will also cover more complex services such as location

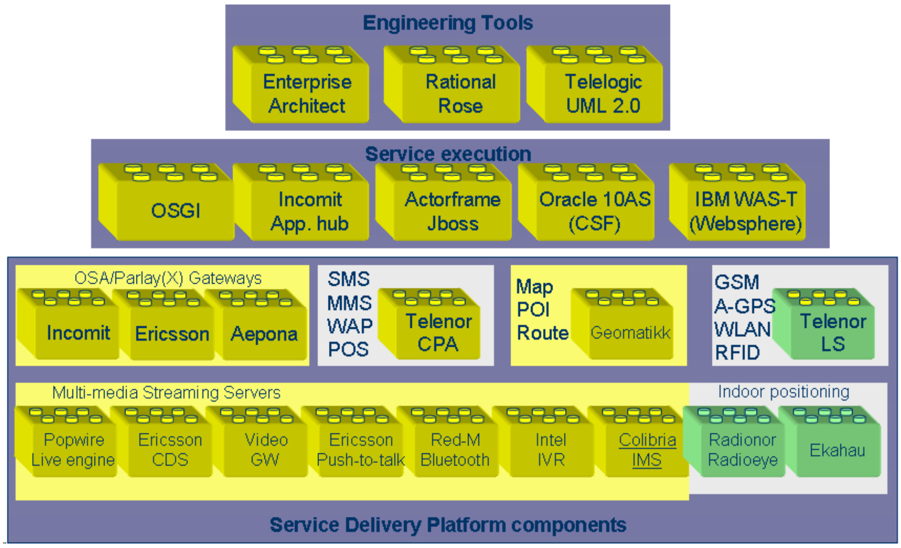

Figure 2. Location information achievable from Telenor's PATS lab

and presence information. Feasibility studies and demonstrations of location roaming in GSM networks have been performed, but are not implemented on an operational level. Similar to the QoS management in GPRS roaming, complexity of handling advanced services has prevented roaming to happen. Mobile based location services are standardized through a Parlay X Web service interface [4]. Even though the interface is standardized, the service as such is not. Location is based on the knowledge of a device connected to a network, and network (cell, and additional information as the time measured for the signal to arrival, the angle of arrival or any external information (e.g. GPS).

Current roaming mechanisms are not appropriate to cover advanced services roaming like location, as they require a frequent update of the service information. Costs for maintaining advanced service roaming prohibit the operational use. The following section provides a short introduction into location services, and then suggests a semantic extension of the service interfaces to allow roaming with minimum maintenance effort.

2.2. Mobile Location information

Telenor provides advanced services through the Innovation lab PATS (Platform for Advanced Telecom Services), which is established through a research program agreement between NTNU, Hewlett-Packard, Ericsson and Telenor. The lab consists of Engineering and development/execution platforms as well as service delivery platforms (Fig. 2).

In this paper we concentrate on location as an example of advanced service. In the PATS lab location can be provided currently through four different units *(a)* Mobile positioning (POS) using the GSM/UMTS positioning in Telenor Mobils network, *(b)* advanced GSM positioning combining GSM location techniques with assisted GPS (A-GPS) provided by Telenor R&D, *(c)* WLAN positioning from Telenor R&D, Radionor or Ekahau, and *(d)* touch-base location systems using RFID or Near Field Communications (NFC).

This set-up presents the complexity of providing location, and even more the complexity of getting location exchange across networks, countries, and operators. We address location roaming between the Orange network in Poland and the Telenor network in Norway. The formats of location data are semantically expressing the same information, the location of the phone, but using different formats. When including WLAN or RFID based location (see Fig. 2), information will be represented through yet another format, making it difficult to provide reliable exchange across operators.

A semantic annotation of information has reached the business market, and allows information exchange across companies. We suggest extending the semantic annotations and use them for the exchange of advanced Telecom services. A semantic extension will allow an easier handling of the different Web service files addressing location information. When connecting the Semantic Web Services (SWS) through a SWS platform, we achieve exchange of roaming information on a dynamic basis. As shown later in the paper, the costs for updating Web service interfaces are substantially reduced, opening for a commercially attractive service roaming.

3. Semantic Annotations of location information

In this section we highlight the potential of semantic annotations in the mediation between advanced Telecom services and present a real case study, i.e. the Orange and Telenor location services. We have selected WSMO [6] for the semantic annotations, mainly because WSMO opens for description of non-functional parameters. In the case of location roaming, such non-functional parameters might be the method used for location detection, the assumed accuracy or the time when location was recorded.

3.1. Steps towards a Semantic Web Service implementation

Semantic annotations recently emerged under the semantic Web umbrella with the aim of providing more explicit representation of data, thus enabling some degree of automation in the manipulation of this data. On the semantic Web data are annotated using ontologies: concepts, relations, instances, and axioms in ontologies give meaning to data on the Web. Because ontologies are shared specifications, the same ontologies can be used for the annotation of multiple data sources, not only limited to Web pages, but also collections of XML documents, relational databases, etc. However, it cannot be assumed that the requester and the provider of a service use the same ontology to annotate their data and thus mediation is required in order to enable communication between heterogeneous business partners. Ontology mediation enables reuse of data across applications on the semantic Web and, in general, cooperation between different organizations.

We focus in this paper on the semantically described location services from Orange and Telenor, assuming that both use the same ontology. Our implementation of the semantic annotation is based on the following steps:

1. Provision of the location services as a Web service
2. Establish a Service Ontology, here specific for the use case scenario.
3. Describe the web service elements in the service ontology, including concepts, types and the relations between the types
4. Specification of non-functional parameters, which are handled by the semantic web services platform
5. Bring the service into the platform, including the mapping from service ontology to platform ontology

3.2. WSMO representation of location services

The ontology for advanced Telecom services is derived from the domain model containing data types used by the interface definition of atomic services. The types are represented by concepts in the domain ontology, developed specifically for the Adaptive Services Grid (ASG) use cases [7]. Collection and analysis of available information and specifications on telecommunications domain need to be performed, before vertical service domain, process ontologies and a semantic framework will be developed. With respect to the Shared Information Data (SID) of the Telecom Management Forum [8] we have established a definition of domain specific concepts:

```
concept phoneNumber
   number ofType _string
   ()
    concept coordinates
      longitude ofType _float
      latitude ofType _float
```

In addition the ontology defines a full description of the relations between types. Having defined the domain ontology, we need to define a location service ontology. This ontology may be represented through the following declarations:

```
webService
  "http://195.116.60.7:8080/LocateService/services/LocateService"
```

The services are developed for the ASG platform[1], which is capable of handling non-functional parameters, e.g. name, supplier, or method for location.

```
nfp
        dc#title hasValue "OrangeLocateService"
        dc#publisher hasValue "Orange"
endnfp
```

The domain ontology describes the capabilities of the services, and define pre- and post-conditions. An example of a pre-condition is the check is the supplied number is a phone number.

Choreography of the service means a composition of the service in a chain. Grounding stores information where message types are located, mapping between ontology object and parameters of a Web Service:

```
interface OrangeLocateServiceInterface
choreography OrangeLocateServiceChoreography
   stateSignature
   in
     dO#phoneNumber withGrounding
```

[1] Adaptive Services Grid, EU IST project, http://asg-platform.org

```
ssWSDL#wsdl.interfaceMessageReference(OrangeLocateServicePortType/phoneLocation/In)
     out
    dO#location withGrounding
ssWSDL#wsdl.interfaceMessageReference(OrangeLocateServicePortType/phoneLocation/Out)
```

The final step is the declaration of the meaning of the service, here the provision of location information for all provided phone numbers.

```
transitionRules
forAll{?P} with (?P memberOf dO#phoneNumber) do
      add(?L memberOf dO#location and dO#hasLocation(?P,?L))
endForall
```

The following example shows the implementation of the service, using the ASG domain ontology.

```
  concept phoneNumber
    nonFunctionalProperties
      dc#description hasValue "concept of a phone number"
    endNonFunctionalProperties
    countryCode ofType _string
    areaCode ofType _string
    number ofType _string
```

Having performed the steps for both the Orange and the Telenor location service, we have established service roaming for advanced Telecom services. A Semantic Web Services platform like the ASG platform will finally allow a demonstration of the service roaming [9]. We used the current implementation to establish an effort analysis for creating and using semantic web services, as further outlined in the next section.

4. Business Considerations

The effort analysis performed in this section was conducted by domain experts, who implemented location based services in the operational networks of Telenor and TP/Orange. The estimations for manpower usage are thus *educated guesses*, and the specific numbers should be verified when used in other domains or other services. However, the authors are confident that the general trends are representative for advanced service provision for mobile users. The estimations relate to the following steps:

1. Create a service overview, here addressing services for the mobile user, including location information, routing, points-of-interest (POI) and booking of a service.
2. Identify real world services, here the location services from Telenor and Orange and make them available as Web services.
3. Establish the methodology to convert the existing Web services to semantic web services, and make them available in an application. Our methodology is based on the three areas:

- Svc: The Semantic Service Creation, including semantic description of the service, service testing and registration at the service platform.
- Dmn: Domain Ontology development, required for defining the service landscape semantically.
- App: The End-user Application, which is the interface for real users to address the services.

Addressing the life-time of a product means analysing the costs/effort it takes to establish a service, to maintain the service and to modify/upgrade a service. Our analysis aims in comparing conventional services with semantic web services. The efforts in person days (pd) per step are estimated efforts based on the experiences from the implementation of semantic based location services. The usage of semantics for services incorporates the following changes:

- Svc Service creation: We assume that services are available as Web services, and thus the main effort is to establish a semantic service description.
- Svc - Service testing is easier in a semantic web service environment, as a testing suite has to be written only once, and can be used for all testing of all services.
- Svc Service registration is of similar effort for conventional and semantically based services.
- Dmn Domain ontology development is only needed for SWS, and is a clear cost driver.
- App application development is not considered now, but is subject to further work.

Table 1. Deducted efforts for semantic service provision compared to conventional service provision

Description	1. service provider		2. service provider		
	1. serv.[pd]	2. serv.[pd]	1. serv.[pd]	2. serv.[pd]	Conv. serv.
Svc semantic description	20	4	5	2	0
Svc - testing	3	0	1	0	4
Svc - registration	3	2	1	1	2
Dmn creation/ update	30	3	4	1	0
App not considered	-	-	-	-	-

The effort (in person days [pd]) presented in Tab. 1 is presented as effort needed for the first service provider, e.g. Telenor, and a second service provider, e.g. Orange for the same service. We assume that the second provider can reuse the results from the first provider, and uses less effort to establish the same service. Using the deducted effort for semantic service delivery of Tab. 1, and apply them to two service providers with up to 5 services each, results in the effort presented in Fig. 3. The following conclusions can be drawn. The initial service creation for SWS drives costs. For one service provider it needs more than 10 services in same domain to be competitive to conventional service delivery. If multiple service providers for similar service, SWS delivery is superior for three and more services (and two providers).

If we include the domain ontology development and update, we receive the results of Fig. 4. It shows that the development of the domain ontology is the cost driver, but only for the first provider. A

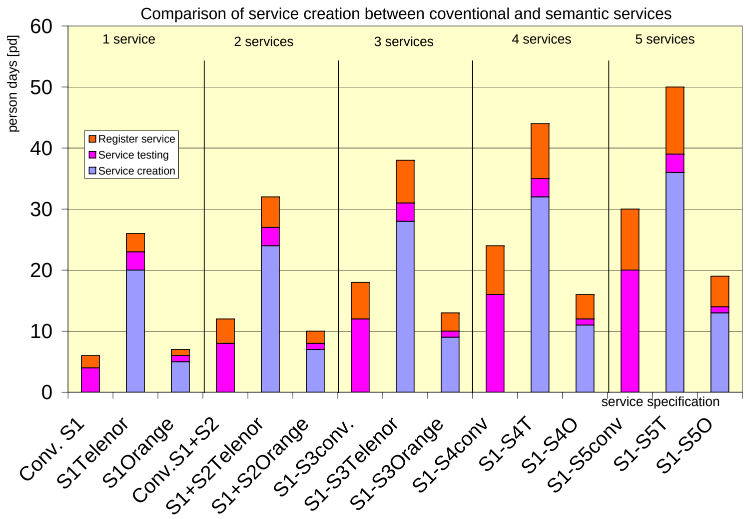

Figure 3. Comparision of service creation costs between SWS and conventional service provision

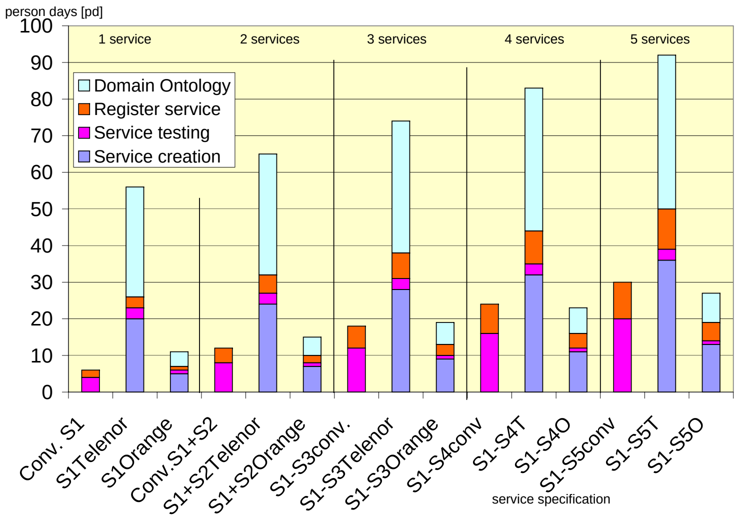

Figure 4. Costs of service creation, registration, testing and domain ontology creation

second provider will only see incremental costs for the domain ontology adaptation. He will already see cost benefits when providing 5 services.

Further work is ongoing to include the update of the services, which we expect to provide an even more advantageous picture for SWS delivery.

5. Conclusions

This paper addressed business aspects of semantic service delivery, based on services for the mobile user. Location service is selected as initial service, as it is the basis for advanced services such as points-of-interest, routing and emergency help. Location services points out the complexity of mobile, GPS, WLAN or touch-based location. Current roaming mechanisms are not appropriate to cover advanced service roaming, as they are based on static interface definitions to Web Services. To tackle the challenges we proposed WSMO-based annotations of location services, as WSMO allows a.o. the description of non-functional parameters.

Based on existing location services from Orange in Poland and Telenor in Norway we showed how the services are modelled with WSMO. Having the semantic representation in place, a service exchange centre can base the roaming on these representation rather than static service interfaces. Global service roaming will be based on heterogeneous service descriptions and ontologies. The paper presented initial business considerations for semantic web service delivery, showing that the initial costs for developing semantic services are high. SWS will benefit when implementing services from multiple providers. In our service example a second provider will already benefit from SWS when providing more than 5 services in the domain.

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