# Integration of Human Services into Technical GI Service Chains

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**SUMMARY**

*E-business is emerging in the market for geographic information (GI). Mostly, offered products are data and some technical services, which do not match the demand of business customers. They require complex GI-solutions, which integrate human services, e.g., consulting, software adaptation, and training. We suggest electronic GI marketplaces for enabling GI service chains integrating technical and human services. The implementation of technical services in an internet business platform requires an ontology-based semantic description language. The most advanced language is OWL-S (formerly DAML-S). The implementation of human services in internet-based service chains also requires semantics. This paper will demonstrate by a typical business scenario, that i. OWL-S fulfills the requirements of a semantic enabling web description for human services and ii. Integration of human and technical GI services in an internet-based service chain can be implemented by the common language OWL-S and thus enhancing GI business by connecting customers and providers.*

**KEYWORDS:** *GI marketplace, Service chain, Semantic interoperability, OWL-S*

## INTRODUCTION

Still the GI market steps behind the expected market growth (Fornefeld, Oefinger et al. 2003). E-business is emerging in the GI market in order to promote GI products, e.g., Terramapserver (www.terramapserver.de) and On-geo GmbH (http://www.on-geo.de/). However, currently e-business does not affect the crucial needs of a prosperous market: the provision of demanded products in an appropriate way.

A typical GI product required by a bank consists of a set of intermediate products: data, software, technical, human, organizational, and institutional services. Current internet platforms mostly sell data, but they offer few additional GI services. This leads to interruptions of business transactions.

We have tested the mismatch of demand and offer in previous work (Brox and Kuhn 2004). In a scenario we investigated, if a bank manager could order a required GI product at three existing internet-based GI platforms. The demanded product was a GI system for an annual evaluation of the bank's branches, to be integrated into the in-house system and business processes. The provision of the demanded end-product required several services as intermediate products, e.g., consulting, delivery of geographic data, GI software, integration of data, integration of GI software into the business system, and training of employees on the new system.

The tested internet platforms almost only offered data and software. On the other hand, the price of the demanded end products resulted by only ~ 10 % of the total costs of data and software. ~ 90 % of the total costs were due to additional human GI services. The mismatch between offer and demand prevented to start business. A bank manager did not get sufficient information about the costs and the benefit of the desired product. The business transaction was stopped at its first step: information retrieval.

This scenario proofed two major impediments of the GI market:

- The neglecting of the need of additional services in order to make usable end products out of the raw products data and technical services
- Outdated monolithic business models instead of cooperation of business networks, where different providers contribute with their specific core competences and intermediate products to the demanded, complex end product.

For the establishment and coordination of business networks, we previously suggested electronic GI marketplaces (Brox and Kuhn 2001). A GI marketplace provides organizational and institutional services for business customers and business providers, e.g., creating business networks, marketing for GI products, and defining standards for business transactions. Based on this framework, GI marketplaces enable and/or perform human and technical GI services, dependent on the GI marketplace's business model.

This paper addresses the ongoing challenge how to establish a consistent service chain on a GI marketplace, which results the required end product. A customer requires an internet-based business process on a single platform. This affects the need of the integration of different types of services: technical services, e.g., "view map", have to be combined with human services, e.g., "evaluate data set appropriate to user's requirements".

In general economy, we observe the increasing use of semantic enabling languages, and ontologies. The first level is a semantic description of product catalogues, e.g., by (Angele and Erdmann 2001). The more advanced level is to handle more complex objects. Semantic enabling description languages are used for knowledge and content management. For example, the INKASS project (Abecker, Apostolou et al. 2003) targets the trade of knowledge on electronic marketplaces by using ontologies for the description of existing knowledge in the Web and, the more advanced step, adding services for enabling business processes.

In the GI world, we can observe a similar evolution. The need for semantics was firstly addressed to geographical objects in data sets. Then, the need for semantic enabling description of services became the next challenge (Kuhn 2002). Mostly, ontologies are used to describe and enable technical service chaining, e.g., (Janowicz and Riedemann 2003). Our paper addresses the ongoing challenge of integrating human services into business processes in order to make GI economically more successful.

The integration of technical and human GI services in internet-based service chains needs a common language for web description and implementation. The most promising candidate seems to be OWL-S (formerly DAML-S) for two reasons:

- OWL-S fulfills the semantic enabling capabilities for technical GI service chaining (Janowicz and Riedemann 2003)
- OWL-S is quite advanced in general economy enabling web services, e.g., by the implementation of the DAML-S Matchmaker, "a Web services registry that enhances the UDDI registry with matching of capabilities of Web services to allow the location of Web services on the bases of what they provide rather than their name, port or other contingent information" (Paololucci, Sycara et al. 2003).

Our previous work showed that OWL-S enables service chaining of technical GI services (Janowicz and Riedemann 2003) because of enabling semantic description. If OWL-S would also be capable to sufficiently describe human GI services, and to integrate both types of services to a human-technical service chain, the provision of complex GI products could be implemented on an electronic GI marketplace. Our paper targets to clarify this question.

The following chapter will provide an overview on the capabilities of OWL-S for technical service chaining as a grounding of this paper. Then, we will analyze the capabilities of OWL-S for implementing integrated human-technical service chains: Our methodological approach will start with setting up a scenario in the third chapter. The scenario is a typical business setting where a bank manager receives the required end product – consisting of delivery and integration of human and technical GI services - via an internet platform. The following chapter will analyze on the basis of the scenario, if OWL-S fulfills the needs of a semantic web description of human services. Afterwards, we will analyze if OWL-S is capable to perform the integration of human and technical GI services into an internet-based service chain. Finally, we will discuss the results and future work.

## SERVICE CHAINING OF TECHNICAL GI-SERVICES BY OWL-S

This chapter provides the grounding of this paper. First, we will provide an overview of OWL-S concepts. Then, we will argue why OWL-S enables technical service chaining.

### Concepts of OWL-S (DAML-S)

DAML-S is the acronym for DARPA Agent Markup Language for Services (DAML-based Web Service Ontology). It is developed by the DAML Group and its last version was 0.9. The recent version 1.0 of DAML-S is renamed to OWL-S because the Web Ontology Language (OWL) is now used to describe service ontologies (DAML-S-Coalition 2003b). This is an important step, because OWL is the ontology description language developed and proposed by the Word Wide Web Consortium (W3C). In this paper we will use the new name (OWL-S) but many tools and the already published literature uses the old term DAML-S. As indicated by the version number, OWL-S is not completely ready yet and there is still a lot of work to do (Sabou, Richards et al. 2003), (Janowicz and Riedemann 2003), for example the monitoring mentioned above is not described in the current OWL-S specification.

An OWL-S service description consists of three parts: Service profile, service model, and service grounding. These aspects, also shown in figure 1, are described briefly in the following paragraphs:

The *service profile* is the part of a OWL-S service ontology that acts as a kind of yellow pages. It is important for the service discovery and answers the question what the services does. In addition to some fixed defined properties, e.g., a contact phone number or a URL, it is possible to define additional service parameters or use offered parameters as geographic radius. In addition to the informational descriptions, the service profile provides functional descriptions, e.g., the specification of the input and output of the service, and its effects and precondition.

The process ontology expresses the *service model* that defines how the service works. There are three types of processes: atomic, simple and composite. Atomic processes are those that cannot be decomposed in less complex ones and are executed in a single step. Simple processes are a method of abstraction and therefore cannot be invocated. Composite processes are those that are composed of atomic or other composite processes by the use of control constructs as loops or if-then-else constructs. The process description plays an important role for the service interoperation, and is also needed for a more precise discovery of complex services.

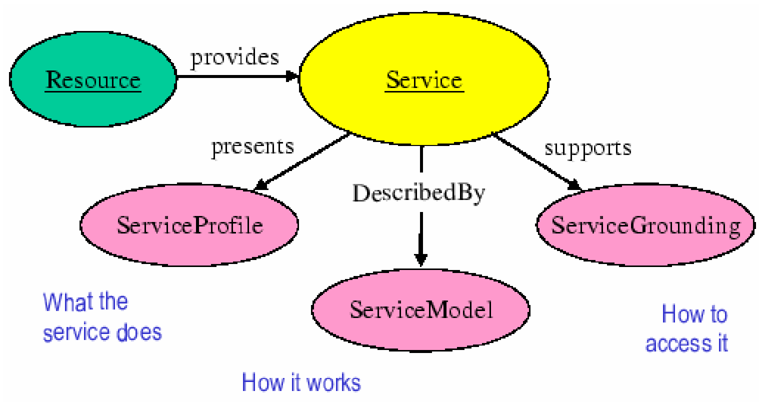


***Figure 1:*** OWL-S service ontology ((DAML-S-Coalition 2003b)

The *service grounding* is the part of a OWL-S service ontology that binds the abstract service specification to a concrete port, protocol etc. It describes how to access the service. Therefore it consists of two parts: a WSDL description and an ontology based description that relates the WSDL part to the service ontology. The service grounding is mostly important for the service invocation but plays a role in interoperability as well.

A service composition language must be able not only to express the concept of a composite service but also to specify how the parameters are bounded together and how the data gets from one part of the composite service to the next one. Up to now this still remains a problem in the OWL-S specifications. The current solution presented there seems to be a makeshift only.

## Capabilities of OWL-S

There are several existing and upcoming technologies and frameworks to enable automatic service chaining. By using web description languages as BPEL4WS (Andrews, Curbera et al. 2003) or OWL-S (DAML-S-Coalition 2003b) it is possible to describe simple, atomic services and their composition to more complex ones. (Corcho, Fernández-López et al. 2001) provide an overview of the technical state-of-the-art in ontology technologies. (Otto and Waesch 2003) evaluates business frameworks as ebXML, RosettaNet, and BPEL4WS regarding requirements of inter-organizational business process integration.

Depending on the aim, each framework or language fulfils more or less the criteria that are needed for service chaining. We decide to use OWL-S here, for the following reasons:

First, OWL-S is an ontology based, semantic enabled markup language that claims to allow the automatic discovery, invocation, composition and interoperation, execution and monitoring of web services. Especially when thinking about complex service chains offered on a GI marketplace the importance of semantics becomes obvious: Without an explicit, shared understanding of the data and services dealt with it is impossible to chain them together. For example, a service will not deliver reasonable results, if input data do not sufficiently specify how the required service should look like (Janowicz and Riedemann 2003).

Second, OWL-S supports the creation and usage of complex services (Paololucci, Sycara et al. 2003). As mentioned above it supports the discovery of simple and composite services e.g. within registries and catalogs. This is especially important on GI marketplaces, because the user must be able to choose a suitable product out of a high amount of products. Therefore an explicit human and machine understandable kind of yellow pages is needed, and this is in fact offered by OWL-S. To support the interoperation of services it is moreover necessary to describe the model behind a composite service, e.g. to describe which atomic services it is composed of or what effects arise while running the service. This kind of information can be described with help of the OWL-S service model. The next important aspect of service chaining it that it must be possible to track the service in a way that the user or an agent can detect the actual position of the service and can find out whether problems are arising or not. This requirement is as well covered by OWL-S. Summarized, OWL-S is a semantic enabled markup language that covers the most important aspects of automatic, technical service chaining. But what about the human parts of a complex chain as described above?

## SCENARIO

The use of scenarios is a method to develop, test, and demonstrate a theoretical concept. Focusing on a small, practical, and known example facilitates the understanding and analysis of a complex problem. The scenario focuses on the first critical step of a business transaction: information retrieval. Currently, internet platforms for geographic information are often not able to answer a simple customer's question (Brox and Kuhn 2004): What is the price I have to pay for the required product?

The overall scenario is a bank, which targets the evaluation of the locations of its branches. The evaluation targets a priority list of existent and planned localities by the comparison of costs and market potential. The final goal is to decide about improvements of branches, shifting or closing of existing localities, and opening new ones. The evaluation is based on enterprise and demographic data, and it shall be supported by geographic information. The bank repeats the evaluation every year. Therefore, the bank needs a tool and working processes for an in-house execution.

The generation of the desired end product includes different tasks, e.g., finding business partners, define requirements for needed data sets and GI software, integrate data and software into the bank's business system, and training of employees on the new system.

Within the overall scenario, we will separate a single business process of information retrieval addressing costs for buying and integrating a suitable data set (see figure 2): The business process starts with the request of a bank manager for an offer to evaluate, and integrate a suitable data set. The bank manager fills in his request in an electronic form provided by the GI marketplace. The GI marketplace addresses the request to three GI consulters, which – according to the GI Marketplaces' database could potentially do the job. In addition, the GI marketplace evaluates by customer's request potential data providers and data integrators. This information the GI marketplace transmits with addressing the customer's request to the GI consulter.

Two of the addressed GI consulters internally decide not to process the request, one decides to do. The GI consulter checks potential data providers by viewing their data and relevant metadata information. After deciding for a suitable data set, the GI consulter addresses the customer's request for data integration to two data integrators. One of them sends back an offer for the integration service. The GI consulter evaluates all information and sends an offer for the required end product to the bank manager via the GI marketplace.

Figure 2 shows different types of services. We classify them into three groups: technical GI services, human GI services, and organizational services. The latter are notification services of the players of the scenario in order to inform the business partners about the fulfillment of a request, e.g., by email.

We consider services as technical GI services if automated processing is state-of-the-art on the GI market, mainly when OGC specifications are available or planned, e.g., Web Mapping Services, Web Feature Services, and Catalogue Services or if there are accessible Web Services available.

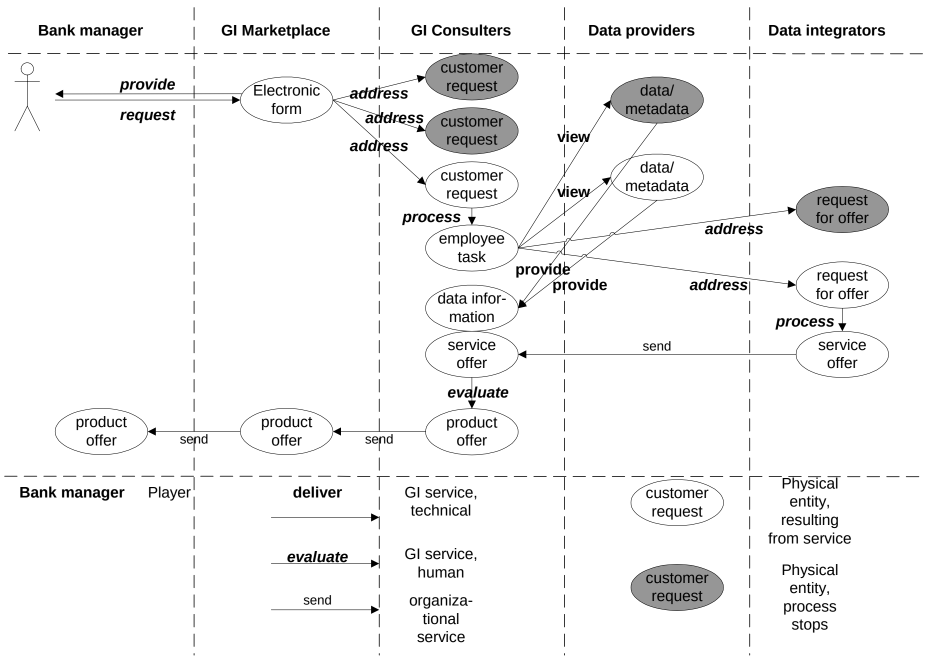


***Figure 2:*** Services for information provision about costs of buying and integrating a data set

On the other hand, human GI services are provided by human beings, e.g., processing a request for an offer of integrating a data set. However, differentiation becomes weaker in other cases. For example, nowadays a common business process of the GI market is thinking about a data integrator who could potentially do the required job, or looking for one in the internet. Our paper targets the automation of this process by matching specified requests for services with specified offers. Thus, we classify some GI services, e.g., "address", as human services because it is the state-of-the-art, although a successful implementation would turn them to technical GI services.

Is OWL-S capable to describe the business process of the scenario in an appropriate way? The following two chapters will analyze the requirements of web description and its fulfillment by OWL-S for

- Human GI services,
- And the integration of both types of services in human-technical service chaining.

## INTEGRATION OF HUMAN SERVICES IN HUMAN-TECHNICAL SERVICE CHAINING BY OWL-S

This chapter elucidates the requirements of human services to be described by a web language, and analyses how the requirements are fulfilled by OWL-S.

### Requirements

In the scenario, we observe two groups of human services

- Internal processing of user request by employees of GI consulter and data integrator ("process" and "evaluate")
- Matching of user requests and potential providers ("provide", "request", and "address")

As an example, we take the human services of the GI consulter "process" and "evaluate". These services are very complex, and they involve the invocation of further services, addressing the technical service towards the data provider, and the human service addressing the data integrator.

However, the human services of the GI consulter have a defined, physical input (customer request) and output (product offer), as well as parameters of the human service itself. The precise, machine-readable description has to enable

- The integration of the human service in an internet-based business process
- And finding the service in the Web, matching it with the user's request, and thus addressing a "correct" GI consulter who is capable to do the required work.

A web description language has to describe the following parameters of a human GI service:

- Type, e.g., gather information, evaluate information
- Context, e.g., geographic data, socio-demographic data, data integration, GIS training
- Communities, e.g., providing GI services addressing banks, insurance companies, and local authorities
- Technical requirements for interaction, e.g., hardware requirements, software requirements
- Method of interaction, e.g., input and output, electronic form for customer request and product offer
- Price of offered services, possibly deviation from offered prices, e.g., rate of person hour
- Address of provider, e.g., town, street, telephone number, fax, email address
- Geographical position and possible limitation of service offers to regions
- Time, e.g., opening hours
- Language, e.g., national or international services
- Legal aspects, e.g., time limitation of offered product, location of responsible jurisdiction.

Is there a need for semantic for human services? Yes it is. Simplifying one could divide two types of semantic problems in human interaction. The first is the group of problems that arises when two persons have to communicate personally. This kind of semantic mismatching is not dealt with here because it is not a problem of computer semantics. The second group arises by the communication of human users with technical services. It must be clear to the user what kind of input the service needs and what output will result from it. This plays an important role in service discovery but also in the later interaction with the chosen service. For example it is not trivial to fill out even a form of a web interface without the needed community vocabulary. Therefore this vocabulary has to be defined in an explicit way, for example by using ontologies.

Consequently, a service chain of technical and human services has to be described in a semantic enabled way. Thereby the demands for a human service description are not as far away from that of technical. For example, a human service can also consist of some simple services. These services are also composed together by control constructs, e.g. if a GI-consulter is not able to find suitable data from a first provider, then he has to search at a second one. However, technical services have a concrete grounding to a communication protocol, port number etc..

We showed that matching user request and providers' offers need a semantic enabling web description language. OWL-S is the best candidate. Does it fulfill the requirements?

## Fulfillment of requirements by OWL-S

The following paragraphs compare the three main parts of OWL-S service ontology with the needs of human services:

Service profile for human services

As described above the OWL-S service profile acts as a kind of yellow pages. Service parameter as geographic radius and phone number are also necessary for human services. More over it is possible to specify own, additional service parameters that are especially important for human users. For example the legal aspects of a service can be described as service parameter. Input, output, and preconditions are not the concepts we think of when talking about human communication, but we can assume that an interaction between a user and a consulter may look like this (simplified). For example the user describes his required product to the consulter as input; the consulter is looking for solutions and returns an offer as output. Human communication is much more complex and belongs of the first part of problems described above. This paper focuses on the description of input and output that a technical service submits to a human service or the other way around. That means that one of the communication partners is always a technical one. And in this case it is possible to speak form outputs and inputs in the way computer scientists do. Regarding to the scenario the service profile plays the most important role when the bank manager is trying to find a suitable GI consulter and when the consulter is looking for integrators and data providers. Summarized, OWL-S service profile can be used for human services.

Service process for human services

The process description proposed by OWL-S is necessary for a more specialized discovery but mostly for the interoperation and composition of services to more complex ones. As mentioned above there are two types of human services. Human processes on the one hand and human to technical service interaction on the other hand. The scenario shows both types of services. The first one, for example when the GI consulter delegates a task to his employee, is not of interest for a representation of the service to third parties. In this case the human service can be represented by a OWL-S atomic process and a simple process can be used as abstraction that can act as a kind of black box to be expanded to a complex process if needed. The second type of human service can be also represented in this way. In this case the aspect of grounding becomes important and will be discussed below. Like argued above human services can also be composed be control constructs, this is true for both types of human services. For example the GI consulter can look as long for data integrators until he found one that is suitable to integrate a special data format like ATKIS. This is a kind of loop, which can be represented as OWL-S Repeat-Until control construct. In our opinion input and outputs can be defined in the same way as by technical GI services, especially if one of the both partners is always technical partner as shown in the scenario above.

The actual OWL-S specifications force grounding for atomic processes and therefore also for composite processes, this is a problem when trying to describe human services. Summarized, OWL-S service process can be used for human services, too.

Service grounding for human services

The third part of OWL-S service ontology is the grounding. Because OWL-S focuses on automatic service chaining the grounding is necessary to enable the communication between two technical services. The problems arising here for human services are mostly related to WSDL.

WDSL is a description language that describes web service interfaces in a syntactical way. The WSDL description is related to the service process of OWL-S by a special WSDL grounding class. Human services can not be grounded in a way like this. It is possible to describe the input and outputs of a human service by WDSL and also one can argue that a human service can be reachable through a web protocol or by a mail protocol like SMTP. This would mean that the service sends his output per mail to the human service (the GI-Consulter from our scenario) and the service is responding by mail or per web interface. On the first view this looks like a suitable way of grounding for human services, but most of the web services are not made for asynchronous communication like intended by SOAP as main communication protocol for web services (Simonis and Wytzisk 2003), for example an GI consulter is not available at every time seven days a week.

The OWL-S service grounding is the only part of the OWL-S description which is not on an abstract but concrete level. Because OWL-S is especially designed for automated (without human interaction) processing the grounding is the most problematic part of the specification, nevertheless also human services can be grounded.

## DISCUSSION AND FUTURE WORK

The scenario shows that complex GI service chains need human interaction. Consequently, the integration of technical and human GI services in internet-based value chains is crucial to enhance business in the GI market.

The first group of the scenario's human services consists of services in terms of internal processing of user requests. They hardly can be automated. These services, e.g., the GI consulter evaluating the required information in order to provide a product offer, will remain handicraft in the GI world. However, the evaluation of required information is an essential service for providing the desired end product and consequently has to be integrated into the service chain.

The second group of the scenario's human services matches user requests with potential providers in order to address potential providers that are able to execute the required service in an appropriate way. Nowadays, this is a human service in GI business. This service can be automated and implemented as a technical service; recent approaches as DAML-S Matchmaker (Paololucci, Sycara et al. 2003) demonstrate feasibility.

OWL-S is a semantic markup language that supports automated service chaining. By its concepts, OWL-S is capable to describe human-technical service chaining in an appropriate way. However, in the current version 1.0 it cannot be adapted one to one for the needs of human service description. As we have shown in this paper the requirements of human services are close to those of technical services. When the human services are chained with technical services, OWL-S service ontology can be used for their description. This is mostly due to the fact that the OWL-S description is made on a abstract level and only the grounding is on a concrete level.

The integration of human actors within such services will be the next steps to enabling the creation of complex, not trivial services that need human expert knowledge. OWL-S is focusing on automated services and is not made for human services, but it can be adapted to such needs.

OWL-S is still in an early phase of specification. With the change to from DAML+OIL to OWL it will come closer to the semantic web world and the W3C. This will make OWL-S to the leading standard for semantic service chaining. A lot of research groups are working on tools (Lab 2003), (Klein and König-Ries 2003) and frameworks (Klein and König-Ries 2003), (Sabou, Richards et al. 2003) for this language and will enable a more effective and comparable way of service annotation.

An OWL-S service ontology is only a first step to enable service chaining. Even more important is a clear and entire specification of the concepts of those objects that are used or manipulated by the services. For example the bank manager may have a completely different opinion about what maps or statistics are, than the GI consulter. While human actors are able to exchange their arguments and find a common definition for things like maps, this is not trivial for software agents and services. Therefore local ontologies are needed to specify the world view of each agent, service or provider (Uschold 2000). These ontologies must contain the specification of all resources (DAML-S-Coalition 2003a) in a machine-interpretable way, for example using OWL. Only if this is done, the technical services will be able to interact in a sense full way, because they "understand" the world view of each other. In fact the problem is even more complex, because it is not enough to just know or understand the world view of another party to interoperate with it. Before communicating a service has to map his conceptualization to that of the following service of the complex service chain, so that they speak a common language. This mapping can be supported by relating the local ontologies to global ones (e.g. SUMO (http://ontology.teknowledge.com/). In this case it is possible to analyze in which neighborhood or relation the different concepts stand to each other.

Recently a lot of research is done in this area (Maedche, Motik et al. 2002; Magnini, Serafini et al. 2002; Silva and Rocha 2003b) and a much further work is left. Information on the recent work in the context of "E-Business Interoperability through Ontology Semantic Mapping" can be found in (Silva and Rocha 2003a).

Further work will focus on providing a prototypical implementation of the scenario with the OWL-S. Mayor challenge will be the ontology-based formalization of inputs and output of human services. Many services involve a notification. However, mostly it is not a synchronous notification with basic request-response mechanisms. Notifications are more complex and need to handle delays and failures. (Simonis and Wytzisk 2003) provided an OGC conformant Web Notification Service (WNS). Although focused on technical GI services, in principal WNS can handle several types of notification, e.g., email, SMS, phone call, and letter. The WNS on in the OGC process becoming an OGC standard. Therefore, such a standard should be integrated into the business processes on a GI marketplace.

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