TOWARDS SEMANTIC WEB SERVICES FOR PUBLIC ADMINISTRATION BASED ON THE WEB SERVICE MODELING ONTOLOGY (WSMO) AND THE GOVERNANCE ENTERPRISE ARCHITECTURE (GEA)

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Abstract – In this paper we present our work regarding a combination of a generic service model ontology as defined by WSMO (Web Service Modeling Ontology) with generic Public Administration (PA) domain descriptions, models and concepts as introduced by the Governance Enterprise Architecture (GEA). Our aim is to show how specific Semantic Web Services concepts can facilitate a PA service model with the use of the descriptive power of WSMO and the PA specific se-mantics from GEA.

1. Introduction – Motivation

During the last years, there is a growing interest in the area of Semantic Web Ser-vices. In this area, there are several modeling attempts to provide formal descriptions of a service (e.g. WSMO , OWL-S , WSDL-S , or METEOR-S . These initiatives aim to propose standardized service description or so called service ontologies.

On the other hand, in public administration (PA) there are several attempts to model common aspects and generic features of the domain, with emphasis on service and process models. In [12], several relevant initiatives are presented and commented
Among them is the Governance Enterprise Architecture (GEA)[1,4],[13]. Until now, these two modeling streams of work have not been adequately connected. There are no efforts trying to combine a generic service ontology with PA domain specific models in order to present rich PA service descriptions with executable features in a Web Service technological environment. In other words, there are no do-main specializations/instantiations of generic service ontologies. Especially in PA, these detailed service description would be very useful,

in order to solve some demanding semantic interoperability problems in the particularly complex and distributed environment of PA. In [14] some of the underlying semantic requirements for European PAs are discussed.

In this paper we present our existing work in linking the Web Service Modeling On-tology (WSMO) with the Governance Enterprise Architecture (GEA) PA Service model. At this stage, "linking" means providing the conceptual mapping between the two service views of these two modeling efforts. The goal of this research work is to propose a WSMO representation of a PA service model taking into account domain semantics as modeled in GEA. The WSMO representation of a PA service model will capture and manifest PA-specific representation features enabling intelligent and client-friendly PA service discovery, composition, invocation, execution and monitoring.

In the next part, we briefly introduce GEA[1,4] and the GEA PA Service Model. Then, we present an overview of WSMO. In the fourth part, we provide the conceptual mapping between the two service descriptions. This mapping constitutes the basis upon which the PA service model will be described using WSMO. Last, in the conclusions we provide our plan for future work.

2. The Governance Enterprise Architecture

GEA aims at introducing a consistent set of models that constitute the basis for refer-ence eGovernment domain ontology. This ontology is generic enough to cover the overall eGovernment domain, and at the same time specific enough to sufficiently model PA specific semantics. A key aspect of GEA is that it attempts to be technology-neutral. This means that the GEA models may be applicable to different techno-logical environments. A GEA overview can be found in [2]. The models are presented in detail, in [3-9].

For the purpose of this paper, we focus on the GEA detailed object model for service provision referred to in this paper as the PA Service Model for the sake of brevity. This stems from the fact that it is this model that is directly linked to the representation of a PA service, and thus is most relevant to WSMO.

2.1 The GEA detailed object model for service provision

The overall model [4] is presented in Figure 1. A brief textual description follows

Societal Entities (e.g. citizen, business) have *Needs* related to specific *Goals*. A Societal Entity requests a *Public Administration (PA) Service* to serve its Goals.

There are two categories of *Governance Entities* participating in service provision: *Political Entities* and *Public Administration Entities*. Based on the role which PA Entities can acquire during the service execution phase, we identify three roles:

Service Provider is the PA Entity that provides the service to the Societal Entities (clients).

Evidence Provider is the PA Entity that provides necessary Evidence to the Service Provider in order to execute the PA Service.

Consequence Receiver is the PA Entity that should be informed about a PA Service execution.

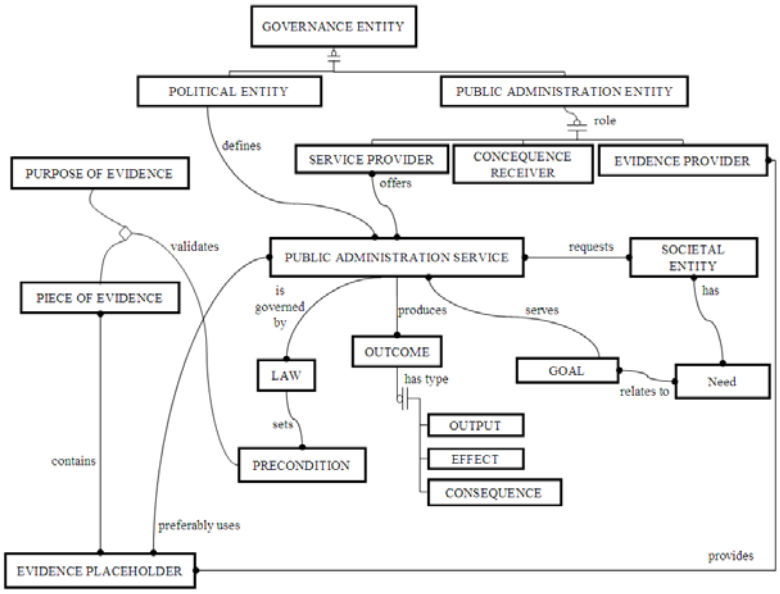

Figure 1 : The GEA PA Service Model

Political Entities define *PA Services*. PA Entities through their role of Service Provider offers these services. PA Services are governed by *Preconditions* usually specified in *Legal Acts - Laws*. Preconditions set the general framework in which the service should be performed and the underlying business rules that should be fulfilled for the successful execution of the PA Service. Preconditions can be formally expressed as a set of clauses.

Preconditions are validated by *Piece of Evidence* serving a *Purpose*. As Evidence is primarily pure information, it is stored in Evidence Placeholders, thus the Evidence Placeholder contains Pieces of Evidences. The m:n relationship between the two entities expresses the fact that specific Evidence can be found in numerous different Evidence Placeholders. For example, a citizen's age, serving as a Piece of Evidence for a service that sets age limitations in its Pre-conditions, can be contained in the ID card, the passport or the birth certificate. These are considered as alternative Evidence Placeholders. There are many cases where the Evidence Placeholders are provided by PA Entities (Evidence Providers).

The direct relationship between PA Service and Evidence Placeholder depicts cases where PA Services preferably use specific types of Evidence Placeholders, e.g. when the law explicitly states that a birth certificate is needed for the execution of a particular service.

The *Outcome* refers to the different types of results a PA Service may have. GEA defines three types of Outcome:

Output – is the documented decision of the Service Provider regarding the service asked by a Societal Entity. This "documented decision" is currently embedded and reaches the client in the form of an administrative document/decision.

Effect – the execution of a service may result in a change in the state of the world (e.g. transfer money to an account). In the PA domain, the service Effect is the actual permission, certificate, restriction or punishment the citizen is finally entitled to. In cases where administration refuses the provision of a service, there is no Effect.

Consequence – is information about the executed PA Service that needs to be forwarded to interested parties. As an example, in Greece someone can adopt a child through a service provided by the Prefecture of the foster parents' residence. The municipalities where the foster parents were born will then have to be informed about the event, in order to update their population registries. This is the Consequence of the adoption service.

In conclusion, from a Model Driven Development (MDD) approach, we may say that the GEA PA Service Model is a "… Computational Independent Model (CIM) describing the business context and business requirements" [15]; in our case, the PA context and requirements.

3. Web Service Modeling Ontology

The Web Service Modelling Ontology (WSMO) [5, 6] aims to define a conceptual model for semantic web services and provide a framework for total or partial automation of tasks such as discovery, selection, composition and invocation of services. WSMO has its conceptual basis in the Web Service Modelling Framework (WSMF) (Fensel & Bussler, 2002), refining and extending this framework by developing a formal service model and WSML ontology language [7, 8]. WSMO serves as basis for the WSMX architecture and execution environment for Semantic Web Services [10].

WSMO identifies four top-level elements as the main concepts, which have to be described in order to define Semantic Web Services:

Ontologies provide the terminology used by other WSMO elements describing relevant aspects of domains of discourse.

Web services represent computational entities, which are able to provide access to services that, in turn, provide some value in a domain.

Goals describe aspects related to user desires with respect to the requested functionality.

Mediators describe elements that handle interoperability problems between different WSMO elements. WSMO defines several types of mediators allowing to resolve incompatibilities on data and process levels as well as allowing to refine goal specifications and map goals to web services.

4. GEA PA Service Model – WSMO Conceptual Mapping

Two distinct conceptual models have been presented so far: the GEA PA Service Model and WSMO. WSMO and GEA PA Services situates themselves on the same level (they both describe a model for services) with some important differences: WSMO defines Semantic Web Services in general and can be used in formalizing a particular, concrete domain (e.g. the one represented by the PA services); GEA defines a particular model applicable only to PA services and it is strongly oriented to this domain. Moreover, WSMO service model is formally defined using WSML language whereas PA service model doesn't use formalize description of its elements.

Our goal is to describe a PA Semantic Web Service by using WSMO conceptual model and WSML ontology language. Within this work we aim to answer following questions: Is

WSMO reach enough to cover the specific details of PA services and to lift them to a semantic and web based level? Are GEA PA Service concepts compatible and equivalent with those introduced by WSMO? How can we use the various WSMO concepts/mechanism to accommodate the domain specific descriptions provided by GEA? And how to combine all the above and at the same time remain compatible with WSMO, in order to be able to use with some level of customization available WSMO tools and execution environments (e.g. WSMO Studio, WSMX).

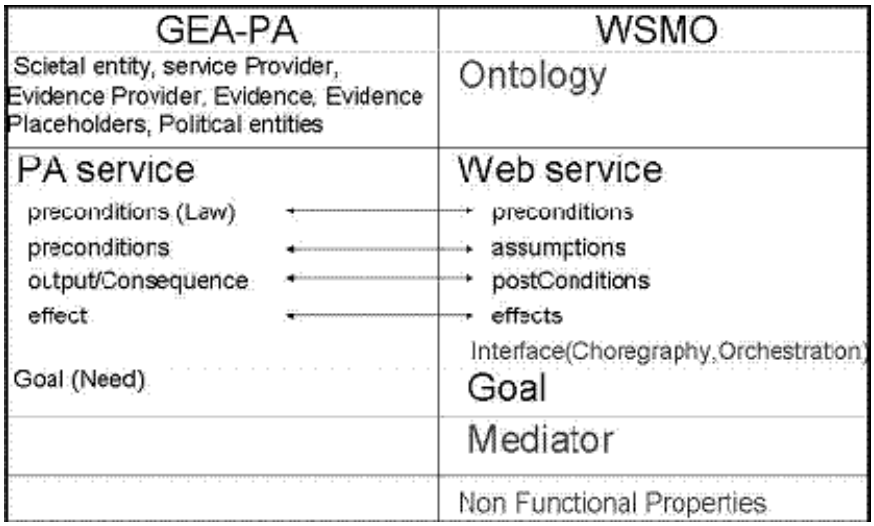

Figure 2: WSMO and GEA concepts

4.1 WSMO Goal

The Goal concept appears to acquire equivalent semantics in both frameworks. Thus, it is easy to map the WSMO Goal with GEA Goal, where both express formally the client's requirements. The Need concept in GEA does not have a direct correspondence in WSMO. It is an informal description of the Goal, as experienced from the client's perspective. There is no equivalent concept for Need in WSMO – WSMO assumes that informally expressed requirements will be transformed to formal goals prior their processing in WSMO environment. This assumption is however beyond the scope of WSMO model. It must be pointed out, that both models support two views; a 'client' and a 'service' view. Other service ontologies like OWL-S do not consider a 'client' view perspective. This is one of the facts that have lead to the selection of the WSMO framework for the implementation of Semantic PA Web Services.

4.2 WSMO Service

The major observation in regards to using WSMO model for PA model is that Public Service entity in GEA is related to the Web Service concept in WSMO. It must be pointed out that the conceptual mapping between the two is possible with an important notice. The Public Service entity in GEA model represents the generic concept of a PA service and it overtly takes a conceptual (business) view. The goal of the GEA descriptions is to present a valid model of a PA service regardless of implementation in technological environment. The WSMO web service concept can represent a se-mantic description of a PA service with ultimate goal to describe this service formally using WSML language and make it executable in a Web Service environment, implemented by lower level technologies (e.g. SOAP, WSDL, application or integration servers, WSMX etc). In this section we discuss how PA service model can be de-scribed using WSMO service concept.

In GEA, precondition represents rules imposed on pieces of evidence (e.g. age must be greater than 18). Both GEA precondition and pieces of evidence should be mod-eled using WSMO precondition allowing required service input to be defined in terms of information as well as constraints on this input. Actual values for evidences as the input to the service are provided during interaction with the service as defined by service choreography interface. The verification of the evidence done through the evidence provider can be modeled as orchestration, when all required input must be verified prior to execution of the actual service. The WSMO service assumption doesn't exist in GEA model as all inputs required for execution of the service should be available in the information space.

The Effect notion implies to the same concept in both frameworks. This is the change in the real world performed after the successful execution of the service. In PA the effect of the service is of particular interest for the client. It is actually the reason, she/he initially invokes the service.

The WSMO Postcondition is equivalent to the GEA Output. They both refer to a state in information space (not to a state of the world). In PA, this change in the information space is triggered by an official administrative decision, which in the current modus operandi is recorded in a document which is considered as the service output. Thus, in current situation, we may say that the service output represents the post-condition of the service or the change in the information space. It should be noted that the GEA Output is at the same time an Evidence Placeholder that is a document in which several evidences (information) are stored and which can be used as input for other services. In WSMO, there is no such element representing Evidence Placeholder – it should be modeled as a concept in the PA ontology. Postconditions capturing evidences can serve as inputs to other services defined as part of orchestration.

The Consequence entity in GEA does not explicitly exist in the WSMO model, but it can be modeled as a part of the WSMO Service orchestration. In this context, the consequences could be fulfilled by invoking other services (consequence services) defined as part of WSMO Web Service orchestration. In this case, WSMO "virtual service" will be created orchestrating the actual WSMO PA service and its required consequence services.

The shared variables concept in WSMO does not map directly to any GEA entity since they are technical instruments that will materialize in the concrete web services WSMO descriptions. Though, the shared variable will be present in the WSMO description of PA services as underlying technology related support.

4.3 WSMO Mediator

From a similar stand point, Mediator concept does not exist in the GEA model. This is due to the fact that the Mediators solve interoperability issues and do not have conceptual "meaning" from the PA and GEA perspective. Mediators will be however used to overcome data and process heterogeneity when different ontologies and different communication patterns will be used by different PA services. Mediators will be in particular important in case of provisioning of cross-border PA services when different formats (ontologies) and PA communication patterns (choreographies) are imposed by different legislation in different countries.

4.4 WSMO Ontology

Another interesting point is the mapping of the Ontology concept in WSMO to the GEA model. There are at least three Ontologies that should be developed in a PA environment:

Law Ontology – this covers and models the GEA Law object. This is a particularly useful (and complex) ontology that is used for extracting the service pre-conditions.

Actors Ontology – this covers and models the GEA Actor objects. This ontology includes e.g. Service Provider, Evidence Provider, etc. In WSMO, non-functional properties could be also used to represent the service actors. But in this case, a serious limitation exists as reasoning is not possible on these types of properties. As the information related to the actor is perceived critical, we in-tend to model this object as WSMO ontology to be used in WSMO Web Service descriptions.

Evidence Ontology including concepts like (a) Evidence e.g. age, sex, number of children, nationality, (b) Evidence Placeholder e.g. ID Card, Passport, Birth Certificate, Building Permission, Driving License and (c) Evidence Purpose e.g. identification of a person. Such an ontology should document the knowledge e.g. that the ID card number is an Evidence that exists in the ID Card Evidence Placeholder and is used by the administrative system to uniquely identify a per-son (Evidence Purpose). The passport number or the Social Security Number may have the same Evidence Purpose in different countries that do not have the practice of issuing ID Cards to its citizens, and thus they may substitute the ID Card number where evidence is needed to prove someone's identity.

5. Conclusion and future work

As presented in this paper we can conclude that WSMO and GEA model are compatible. As GEA model is more specific and domain oriented and thus not all its main entities have a direct correspondent in WSMO. As such, some of the mappings are straightforward while some other mappings have to be fulfilled by combining several WSMO concepts. Concepts not directly related to WSMO will be modeled as WSMO ontologies capturing PA domain specific semantics. These ontologies will be used as part of WSMO element definitions for concrete PA service provisioning. In this way the WSMO model can be applied to the particular domain of PA services using WSMO model without losing the generality of this model and naturally adapting to the specific PA service needs.

This effort will be used as a test-bed for WSMO application to a demanding domain with a lot of special features and characteristics. In our future work, we plan to apply and further develop existing WSMO tools (e.g. WSMX, WSMO Studio, etc.) for the e-government domain. In particular, in our SemanticGov research project, WSMX will serve as an execution environment for PA service provisioning in national and pan-European e-government context. The PA service model described using WSMO will be the underlying specification for PA services provisioning built on WSMX. Standard – standard text

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