Pan-European E-Government Services on the Semantic Web Services

Tomas Vitvar
Digital Enterprise Research Institute
National University of Ireland
Galway, Ireland
tomas.vitvar@deri.org

Adrian Mocan
Digital Enterprise Research Institute
Leopold-Franzens Universitat Innsbruck
Innsbruck, Austria
adrian.mocan@deri.org

Vassilios Peristeras
Centre for Research and Technology Hellas
Thermi Road, Thermi
Thesaloniky, Greece
per@uom.gr

ABSTRACT

Integrated e-government in the European Union requires good conceptual and technological foundations. Aligned with the European e-government strategy, we present how infrastructure for national as well as cross-country e-government services can be facilitated by the Semantic Web Services concepts and technologies. With respect to this infrastructure, we identify key topics for our research.

Keywords

e-government, semantic web services

1. INTRODUCTION

E-Government has been the centre of interest for public administrations, citizens and business as well as software vendors for several years. E-government enables customers and members of the public and private sectors to take advantage of automated administration processes accessible on-line. These activities involve electronic exchange of information to acquire or provide products or services, to place or receive orders or to complete financial transactions. All such communication must be performed securely while at the same time maintaining the privacy of involved parties. The integrity and confidentiality of exchanged messages must also be preserved. Challenges for e-government started to emerge with the development of electronic systems for public bodies to increase the optimality and efficiency of government processes, and to support tasks of public servants by computers. Furthermore, this allows citizens and businesses to process these tasks on-line and with minimal physical interactions with the public bodies. Since a complex information support often needs to be developed incrementally, e-government services were first available as single services in specific sectors and for specific users. While these services are being further developed and expanded to be available in more sectors and for more users, their growing number leads to requirements for total or partial automation of certain tasks, for example discovery, selection, composition and mediation of services. In addition, extensive numbers of such services are available in different sectors and their provisioning in complex scenarios requires a good information strategy. Its main purpose is to identify and define methods, standards, technologies as well as legislation to be used within the whole development process and provisioning of complex e-government systems.

In the EU, the e-government information strategy can be seen at two levels as (1) a European strategy driven by the European Commission to enable e-government services across the EU member states and (2) national strategies to form a national e-government available within a particular EU member state. The initiative which aims to develop the European strategy at the EU level is called IDABC[1] [4]. Based on the fundamental principles of the EU, the goal of IDABC is to promote development and integration of EU sector systems (e.g. transport, health), to develop online front-office services and most importantly to develop an European Interoperability Framework. The purpose of this framework is to define methods, standards and technologies to enable seamless integration of e-government services on a Europe-wide scale. On the other hand, every national strategy aims to build national e-government services. With the aim of being aligned with IDABC, different national initiatives exist, such as GovTalk [16] in the UK, ADAE [17] in France, or REACH [18] in Ireland. They all intend to identify or define methods, standards and technologies and adopt new legislation to build national e-government while at the same time forming a National Interoperability Framework for the respective EU member state. The existence of Pan-European E-Government Services (PEGS) then lies in the integration of National Interoperability Frameworks within the context of the European Interoperability Framework.

In this paper we show how technological aspects of the National/European Interoperability Framework can be addressed by the Semantic Web Service (SWS) specifications. We first describe motivation for our approach and accordingly define conceptual PEGS infrastructure based on the concepts and technologies around the Web Services Modeling Ontology (WSMO). In conclusion, we identify key research and development topics leading to the Pan-European E-Government Infrastructure.

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[1] Interoperable Delivery of European e-Government Services to public Administrations, Businesses and Citizens (IDABC) was established through the Decision 2004/387/EC of the European Parliament.

2. MOTIVATION

Public administrations in their quest to provide services effectively and efficiently to citizens and businesses (further referred to as clients) face various problems. Since it is important to view PA services from clients perspective, we have identified following major objectives for the future e-government, namely (1) service identification, (2) service discovery (3) service execution and monitoring, and (4) interoperability of PA systems.

1. **Service identification**. Initially the client has a need, or an obligation towards public administration. He/she may not know how the administrative system has organized the coverage of the need, and which public services are currently available by which administration to address the need. We may say that in the initial phase of a client-administration interaction the client is need-aware, but not service-aware. On the other hand, public administration is the system that provides the public services. Unfortunately, the need-to-service link is neither always straightforward nor simple. Relevant services may be available from different service providers scattered in both geographic and administrative space. Thus we identify an important gap: administration is service-aware, while its clientele is needs-aware. Only after clients needs are resolved to one or more services, the client becomes service-aware, and thus can communicate with the service-aware administration.

   In order to support clients in their activities regarding service identification, tools for mapping needs to services must be available for clients and must be part of the e-government infrastructure.

2. **Service discovery**. After services have been identified, they now need to be discovered. During the service discovery, following questions should be answered:

   - What is the final result of the service when completed?
   - Which administrative levels provide the service?
   - Where are the specific PAs the client should get in contact with, in order to complete the service?

   In order to support clients and their activities regarding service discovery, PA Service directory (repository) as well as capabilities of discovery and selection of services must be part of the infrastructure.

3. **Service execution and monitoring**. PA services usually require inputs that lead to heavy and demanding workflows with multi-party participation. Many inputs used by a PA service are usually produced by other PA services, and very often, the client acting as a postman amongst agencies has to go through the execution of an extended set of services in order to obtain the input needed by the main service of interest. All these services are intermediate steps of no particular value to the client and thus should be transparently dealt with within the public administration system. Moreover, the client faces serious difficulties in monitoring the progress of execution of complex services. These difficulties also result in hindering service transparency.

   In order to support clients in their activities regarding service execution and monitoring, on-the-fly, semi-automated composition, execution, and monitoring of complex PA services should be part of the infrastructure.

4. **Interoperability of PA systems**. When moving the focus from national to Pan-European e-Government Services (PEGS), additional challenges appear mainly due to the existing inconsistencies amongst the administrative systems. Apart from problems of multilingualism, the clients have to overcome a series of difficulties such as different names for the same services provided by different administrative levels, and providers; different titles, names of documents and their structure; extensive use of different administrative and legal terms; different communication patterns must be followed when interacting with different PAs. Solving these types of inconsistencies more broadly serves and addresses the vision towards the European Administrative Space. This constitutes the main drive towards the direction of enabling client-centric Pan-European e-Government services.

   In order to support requirements regarding interoperability of PA systems and with respect to provision of pan-European e-government services, communal semantic gateway addressing semantic and process mediation to facilitate interoperability among administrative systems should be part of the infrastructure.

While objectives (1), (2), and (3) primarily refer to the local/national level of PA server provision, objective (4) aims at providing the necessary infrastructure to resolve semantic and process incompatibilities at the pan-European service provision. Moreover, in order to successfully reach these objectives, a knowledge infrastructure is needed, i.e. rigorous and reusable public administration domain models as well as technological, organizational, legal and other EU policy issues related to the pan-European e-government should be reflected.

3. PEGS ON SEMANTIC WEB SERVICES

In this section we briefly introduce specifications around WSMO [1, 5], WSML [2] and WSMX [6, 13] and further show how the PEGS infrastructure could be facilitated by these concepts.

3.1 WSMO, WSML, WSMX

By complementing standards around SOAP, WSDL and UDDI, WSMO provides a conceptual model and a language for semantic markup describing all relevant aspects of general services which are accessible through a web service interface. The ultimate goal of such markup is to enable the (total or partial) automation of tasks (e.g. discovery, selection, composition, mediation, execution, monitoring, etc.) involved in both intra- and inter-enterprise integration settings. WSMO defines an underlying model for the WSMX Semantic Web Services execution environment as well as draws up requirements for a WSML ontology language used for formal description of WSMO elements. Thus, WSMO, WSML and WSMX form a complete framework covering all aspects of Semantic Web Services.

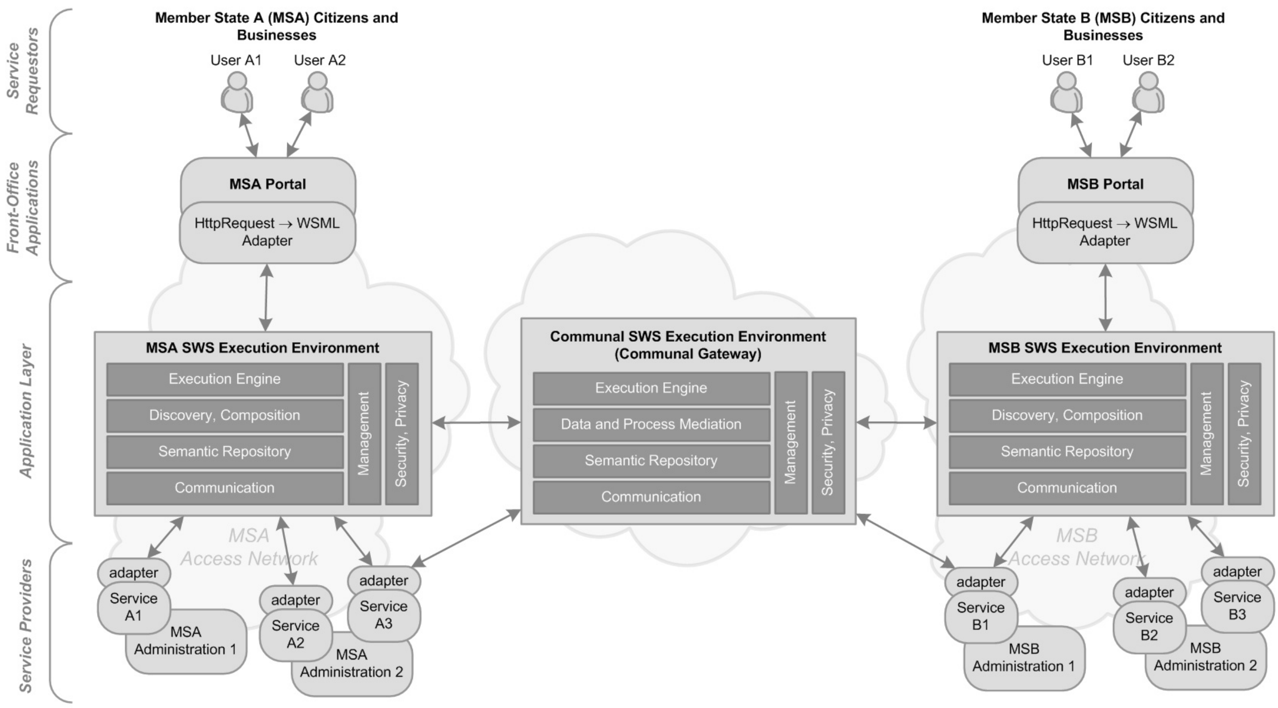

Figure 1: Conceptual Semantic PEGS Infrastructure

3.2 PEGS Infrastructure

In figure 1, conceptual model for the PEGS depicts infrastructure levels such as service requestors, front-office applications, application layer and service providers. The underlying transport network is facilitated by the Trans-European Services for Telematics between Administrations (TESTA) network [15].

- **Service Requestors** are citizens, businesses or civil servants of EU member states. All access front-office applications (e.g. Member State and Communal portals) to specify their needs and inputs.

- **Front-Office Applications** are access points for e-government services. Typical examples are web portals (e.g. portal for the Public Administration of the Czech Republic or portal Your Europe) accessible over the Internet. Apart from providing information, these portals will serve as access points for service requestors to specify their needs and requirements against available (pan-European) e-government services. At this level, transformation of needs to WSML goal and sending the goal to application layer as well as interactions between service requestors and application layer are performed.

- **The Application Layer** takes care of the processing of the WSML goal including interactions with web portals within the SWS execution process including discovery, composition, mediation and invocation of services. In our approach, the PEGS application layer is built on the WSMX Execution Environment. Two types of WSMX environment exist in this infrastructure, one at the national level and one at the communal level. Detail description of WSMX architecture and its components forming particular configuration for application layer is described later in this section. Differences in this configuration may occur based on below mentioned aspects of national or communal environments.

  – *The National SWS Execution Environment* exists for each member state and takes care of processing the requests (goals) of member states citizens, businesses and civil servants. Based on particular National Interoperability Framework, national interoperability standards should be adopted by all public administrations in the country. Thus we presume that no mediation is necessary in cases when only national services are involved in communication (e.g. services B2 and B3 accessed by user B2 in the figure 1). On the other hand, national services which are subject to PEGS must be registered in the communal repositories of the communal SWS execution environment allowing their invocation and mediation within the cross-country e-government processes (e.g. services A3 and B1 accessed by user A1 in the figure 1).

  – *The Communal SWS Execution Environment* exists at the EU level. It acts as the Communal Gateway [12] which facilitates interoperability at (1) the technical level using adapters to adapt different communication protocols and languages, (2) the data/semantic level using data mediators to resolve semantic mismatches of ontologies and (3) final at the process level using process mediators to resolve choreography mismatches of services. In addition, in order to carry out cross-country processes of PEGS, the discovery of SWSs in a national environment involves searching for services in the environments own repositories as well as in the communal repositories. Thus, the communal SWS environment will also provide access to communal services registry of its semantic repository. According to the IDABC specifications, common standards across member states in terms of data and choreography specifications will not always exist, therefore the environment of PEGS will be heterogeneous in nature. The idea is therefore to develop and maintain domain ontology for PEGS to eliminate the total possible number of n*(n - 1) mappings for n ontologies. This will require the Communal Gateway to resolve semantic and choreography mismatches and maintain all mappings centrally.

Following is the description of the typical configuration of the WSMX environment based on the standard WSMX specifications [6]. Differences in this configuration may occur based on above mentioned aspects of national or communal environments.

- *The Execution Engine* controls SWS execution processes by calling various WSMX components according to a defined execution semantics. Within the SWS execution process, discovery, composition, data and process mediation as well as invocation of services is performed. The typical execution process calls discovery of services on reception of a WSML goal, composition of these services into a process, as well as controlling the invocation of services in the process. Data and process mediation is used to resolve semantic or choreography mismatches respectively.
- *Discovery* finds suitable services that satisfy the requestors goal by searching semantic repositories. Discovery searches local as well as communal repositories.
- *Composition* returns a definition of a process in which services will be invoked. Typically, a complex goal is satisfied by more services, thus composition ensures the proper sequence of services to be invoked within the execution of the process.
- *Data Mediation* resolves semantic mismatches between two ontologies by using mappings between the concepts in these ontologies. Data mediation is based on ontology mapping and instance transformation principles and consists of a design-time stage when mapping rules are created and a runtime stage when instances are transformed from instances of the source ontology to instances of the target ontology using these mappings.
- *Process mediation* performs runtime analysis of two given choreography instances and resolves possible mismatches that may appear, for instance grouping several messages into a single one, changing the order of messages or removing some messages from the communication.
- *Communication* consists of the invoker and receiver components. They implement the WSMX entry points responsible for receiving incoming requests and invoking web services respectively. The invoker and receiver also handle grounding of services described in WSML to the underlying WSDL descriptions and the SOAP protocol.
- *Semantic Repository* maintains collection of resources for services, predefined goals, mediation rules and ontologies used within the SWS execution process.
- *Management* is a vertical service within WSMX which applies to all components. It includes WSMX management functions (configuration and monitoring of components, deployment of dynamic execution semantics, managing entries in repositories), and WSMX management tools. WSMX management tools include ontology editors such as WSMO Studio [19], DOME [11] and the Web Services Modeling Toolkit (WSMT) [9] with plugins for ontology management, design-time data mediation mapping creation and WSMX monitoring and management.
- *Security and Privacy* around authentication and authorization of users for accessing services and their resources as well as confidentiality and integrity of exchanged information is an important issue for deploying services. However, security and privacy has not been addressed in the past research within WSMX and thus will be the subject of WSMX near future research.

- **Service Providers** are member state administrations whose services are registered with the WSMX environment. In order to use these services in WSMX, they must be semantically described using WSML and must use the SOAP protocol for communication. For this purpose, specific adapters are developed and used.

4. CONCLUSION AND FUTURE WORK

Development of the Semantic Web Services concepts and technologies is currently purely research topic. The goal is to standardize service model and ontology language for SWS (several standardization efforts have already started through W3C members' submission, such as WSMO[2], OWL-S[3], SWSF[4]), as well as SWS architecture (e.g. OASIS SEE TC[5]). The goal is to exploit SWS research results through industrial collaboration, inject semantics into the state-of-the-art information models and introduce dynamics to system integration process. The approach to the National and Pan-European E-Government being defined within IDABC initiative is conceptualy similar to SWS and WSMO/WSMX in particular. Integrating research results from PA theory (PA Service Model), SWS research (WSMO, WSML, WSMX) and IDABC approach to National and Pan-European E-Government will provide means for fully-fledged Service Oriented Architecture for e-government services available across Europe.

This approach is taken in our EU funded research project called *SemanticGov*[6]. Information presented in this paper

[2]http://www.w3.org/Submission/WSMO/
[3]http://www.w3.org/Submission/OWL-S/
[4]http://www.w3.org/Submission/SWSF/
[5]http://www.oasis-open.org/committees/semantic-ex/
[6]http://www.semantic-gov.org

reflects our initial conceptual model for the Semantic PEGS infrastructure. Within this infrastrucure, our future work lies in various aspects of National/European Interoperability Frameworks based on the WSMO model and WSMX execution environment. Our research topics include:

- **Integration of access portals with Semantic Web Services**. Aligned with efforts in ontology-enabled web portals (e.g. SEAL[7], SPORTS[8]) our aim is to address goal presentation and goal specification to users, support for semi-automated and context-awareness selection of services based on service requestors behavior and profile, etc.
- **Definition of service model for Public Administrations based on WSMO conceptual model**. General service model according to WSMO specifications needs to be verified according to certain requirements from Public Administration (PA) domain. For example, PA domain defines concepts such as Service Consequence [10] with slightly different definition from WSMO Service Interface (choreography and orchestration). The research goal will be to provide WSMO service model for PA domain.
- **Definition, alignment and development of WSMX architecture**. WSMX architecture and its components will be developed based on PA Service Model and requirements from e-government scenarios. This will include advance enhancements of WSMX architecture towards peer-to-peer networks, distributed service discovery and composition, etc.
- **Definition of PA domain ontology**. The research goal is to propose reusable, top-level ontology for the overall PA domain. Such domain ontology is important in order to exploit full range of the Semantic Web Services and reduce heterogeneity of services. We will base our research on the domain modeling principles for modeling complex organization systems as well as PA theory. Implementation of PA domain ontology in WSML language will be provided.
- **New business models for national and PEGS provision**. In order to manage the volume and diversity of social needs and at the same time avoid fragmentation, dissolution and a legitimacy deficit, PA systems need to be reengineered. A paradigm shift of todays modus operandi will be introduced, coupled by new business models in order to facilitate the necessary PA internal and external systemic adjustment. Specifically, PA systems should develop to achieve (1) internal integration at the administrative intra- and inter- agency level, and (2) external integration with society. To this direction, we intend to use SWS architectures, models and technologies to facilitate PA integration in both levels.

Although SemanticGov project is funded from EU research funds (EU FP6 program), exploitation of its results will be done through project's industrial partners, namely CapGemini, Software AG and ALTEC. Having defined case scenarios by user partners (City of Torino, Region of Central Macedonia), SemanticGov architecture built on formalized model for PA services based on WSMO will be implemented using WSMX framework, as well as verified and tested. Our plan is to define and implement conceptual PA domain model based on WSMO by mid of 2006 and accordingly develop prototype for SemanticGov architecture by mid of 2007. We further plan to exploit this architecture through our industrial projects within IDABC.

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6. ADDITIONAL AUTHORS

Konstantinos Tarabanis (Centre for Research and Technology Hellas, Thesaloniky, Greece, per@uom.gr) and Arnold van Overeem (CapGemini, Utrecht, Netherlands, arnold.van.overeem@capgemini.com).

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