INFRASTRUCTURE FOR INTEROPERABILITY OF THE E-GOVERNMENT APPLICATIONS BASED ON SEMANTIC WEB SERVICES

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Abstract

The e-Government interoperability is the ability of ICT components/applications to work together, in other words it is the ability of two or more diverse government (ICT) systems or components to sharing and re-use of information-services, inter-linking of administrative tasks, within and between sectors are essential factors for the delivery of high quality, innovative, seamless and customer-centric e-services.
The organizational interoperability refers to the cooperation way of the public administrations processes, by defining the communication interfaces between processes. This approach addresses the interoperability of e-government applications at organizational and semantic level, adopting Web services (WS) and Semantic Web Services (SWS) as technological solutions. The e-Government interoperability is becoming an increasingly crucial issue, especially for developing countries that have committed to the achievement of the Millennium Development Goals (MDGs) by 2015[3]*. Enhanced government efficiency and effectiveness coupled with the delivery of basic public services to all citizens are essential components required to achieve such goals. In this context, most governments have finalized the design of national e-government strategies and are busy implementing priority programmes. Today the data needed by policy makers to make better decisions is available but inaccessible. Policy makers are faced not only with overlapping and uncoordinated data sources, but also with the absence of common terms of reference and means of representing these data. This results in the time consuming and complex cost of comparing data that is represented differently. Interoperability will allow data compiled by different agencies to be used together to make faster and better decisions. An important goal of governance is to enable the citizenry to have easier and faster access to government information and services. The seamless flow of data from one government office to another provides the policy maker with the information needed to draft sound policy and deliver better services.*

In this paper we present an approach, which addresses the interoperability of e-government applications at organizational and semantic level, adopting Web services (WS) and Semantic Web Services (SWS) as technological solutions. The main objective of this work consists in designing and developing a distributed network of semantic registries in order to publish, find and execute the Web services. The publishing in registries of the Web services consists in the execution of syntactic and semantic matching algorithms between the attributes of the registries and the attributes of Web services.

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3 [7, e-Government Interoperability Guide].

Keywords: e-government application, interoperability, semantic registries, *WSDL standard*.

1 Introduction

Interoperability of computer system is defined by IEEE as "*the ability of two or more systems or components to exchange information and to use the information that has been exchanged*" [8]. Electronic dictionarie defines interoperability as "*The ability of software and hardware on multiple machines from multiple vendors to communicate*". Interoperability is a key requirement in developing e-government applications, which must change data and information between them. There are three levels of interoperability, individualized in the scientific literature such as: *technical level, semantic level* and *organizational level*. Technical interoperability refers to connecting the systems by defining standard protocols and data formats. Semantics interoperability concerns the exchange of information between systems in a manner understood by these systems. Organizational interoperability refers to the cooperation way of the public administrations processes, by defining the communication interfaces between processes. Results of interoperability, incorporating the three important infrastructures (figure 1) described in EC documentation, support three different communities: governance or the administration of government; citizen services; and international coordination [9]. This approach addresses the interoperability of e-government applications at organizational and semantic level, adopting Web services (WS) and Semantic Web Services (SWS) as technological solutions.

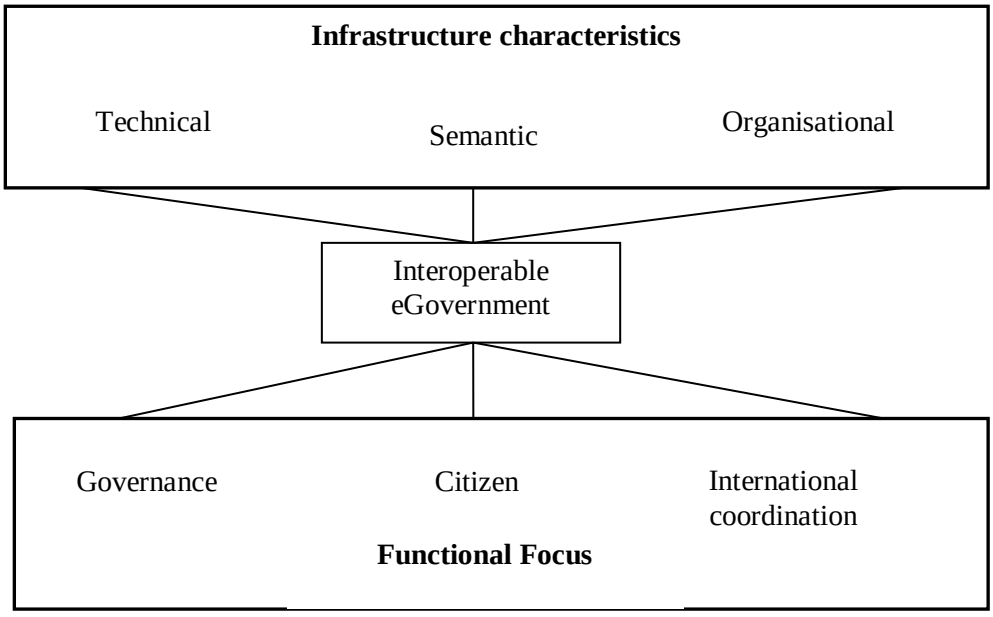

Figure 1 – Infrastructure aspects of Interoperability [9]

The main objective of this work consists in designing and developing a distributed network of semantic registries in order to publish, find and execute the Web services. A web service is a software system identified by a URL, whose public interfaces and bindings are defined and described using XML. Its definition can be discovered by other software systems. These systems may then interact with the web service in a manner prescribed by its definition, using XML-based messages conveyed by Internet protocols [10]. The publishing in registries of the Web services consists in the execution of syntactic and semantic matching algorithms between the attributes of the registries and the attributes of Web services.

The knowledge base used in this approach includes the following ontologies: "*Registries Ontology*", used to specify the public administration domains, the attached registries to each domain to publish the Web services, the relationships between domains and the relationships between registries; "*Domain Functionality Ontology*" used to model the areas functionality and it specifies concepts such as: *generic purpose, generic operation, variable, precondition, post condition, precedence* etc.; "*Service Ontology*" used for modeling the Web services and it specifies concepts such as: domain, purpose, method, choreography message, etc.; "*Domain Ontology*" used for modeling the concepts and relationships within each domain specified in the "Registries" ontology.

2 System Description

2.1 Registries Ontology

Registries Ontology specifies the interest domains of public administration, the registries used within each domain for service publishing, the relationships between the domains, the relationships between registries etc. All concepts of the "Registries" ontology are subclasses of the "Registry" class. The "NodeAddress" property of this class specifies the address of the network node which implements the register. The "Provider", "Reliability", "Fee" and "Availability" attributes specify the provider of the register, respectively the qualitative attributes of the node which implements the register. The figure 2 shows a part of the "Registries" ontology. It exemplifies the "People-Evidence" domain, "ChangeOfCircumstances" subdomain and the "Domain-i" domain. To register the relevant services to "ChangeOfCircumstances" domain it is defined "registry-1" register and to publish the relevant services to "Domain-i" domain is defined "registry-i" register.

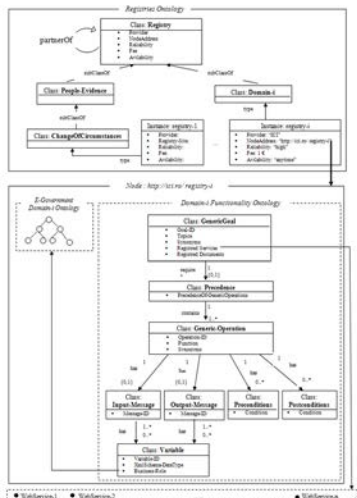

Figure 2 - System's architecture

The "NodeAdress" property of the "registry-i" register contains the address of the node that implements that register: (http://ici.ro/ registry-i).

2.2 Domain Functionality Ontology

The Functionality Ontology of the domain encodes concepts and properties such as: *"GenericGoal", "GenericOperation", "Precedence", "Function", "Topice", "BusinessRole", "Precondition", "Postcondition"* etc. and the relationships between these concepts. The generic goals of a domain are the instances of the "GenericGoal" concept and they represent possible events in that domain. "Topice" and "Synonyms" properties of "GenericGoal" class specify the semantics of the generic purposes. In this example, the "ChangeOfCircumstances" domain, which is a subdomain of the "People-Evidence" domain, contains the following generic purposes: home-changing, civil state changing, name changing etc. The generic operations are instances of the "GenericOperation" concept and they consist on processing used in that domain. The "Function" and "Synonyms" properties of the "GenericOperation" class define the semantics of generic operations. In this example, the "ChangeOfCircumstances" domain contains the generic operations such as: notification of the new home, notification of the new name etc. To each generic purpose is attached a set of generic operations with precedence relationships among them, and these relationships are in accordance with the legislation and regulations on e-government services in the domain. The generic operations contain the input/output messages, and these messages are composed of variables. The variables can be local (recognized only in the context of a single generic operation) or global (recognized in the context of a generic purpose). The semantics of variables is defined by "Business Role" property, which takes values in the set of concepts defined by domain ontology.

2.3 Service Ontology

The Web services are described syntactically in compliance with WSDL standard: port, method, binding, communication protocol etc. In order to add the semantics, the WSDL format extends as follows:

1. for each method of the service it is specified the method functionality using "Function" and "Synonyms" attributes.
2. are specified the purposes of the service using the attributes "Topice", "Domain" and "Synonyms".
3. it is specified the choreography attached to each purpose (method sequence).
4. are specified qualitative attributes of Web service. The "Service" ontology defines the WSDL-S format obtained by extending WSDL format.

2.4 Domain Ontology

The domain ontology defines the concepts and relationships for each existing domain in "Registries" ontology. The domain ontology describes some economic, legal, business and structural aspects. The concepts defined by domain ontology are used for annotation of input/output variables corresponding to generic operations specified in functionality ontology of the domain.

3 The architecture and components

The distributed network used for publishing, retrieving and invoking Web services include the following nodes: one node to implement each register specified in the "Registries" ontology, the "GateWay" node to enter the network, the "Auxiliary" node used as a backup node of the "GateWay" node. The components for registries network management are the following: "Management Registries Ontology" (MRs), "Management Registry" (MR), "Execution and Monitoring Web Services" (EMS).

- the MRs component is implemented in the GateWay node of the network. This component allows to add new domains in the ontology, to create register instances for existing domains, the notification of changes made to the "Auxiliary" node, allows searches in the "Registries" ontology, initialization of the register type nodes;
- the MR component is implemented in each register type node from the network. This component allows the management of the domain ontology, the functionality ontology management of the domain, publishing Web services in the registries, the retrieval of the published services by various criteria;
- the EMS component is implemented in each register type node of the network. This component allows invoking generic purposes defined in domain functionality ontology, mapping the generic goals with the concrete goals which are specified in the description of services, execution and monitoring of concrete goals in accordance with their attached choreographies;
- the described network it is not an authentic "peer-to-peer" network, but it is a hybrid network, because the GateWay node it is the only node that keep up to date the "Registries" ontology and initiate the new nodes added to the network. The GateWay node is the only node that can fail during the change of Registries ontology, but the failure of this node has no impact on the activity of register type node.

4 Scenarios for using the system

The above described system can be used for:

- Web services publishing in a register (R) specified in the "Registries" ontology: the Web service provider describes its service according to the "Service" ontology and sends the description to the network node that implements the R register. The MR component implemented in the node performs the following activities:

a. for each specific scope (S) contained in the service description it is verified the existence of a generic scope (GS) in the domain functionality ontology, so that the description of the S scope matches the description of GS generic scope;
b. it is verified if the descriptions of methods attached to the S scope match the descriptions of generic purposes/scopes attached to the GS generic scope;
c. it is verified if the choreography attached to S scope checks previous relationships attached to the GS generic scope. If the three checks succeed then in the R register it is created the entry (GS, S).

- the execution of Web services published in a register (R):
  a. the user selects the generic scope (GS) that wishes to invoke;
  b. the user selects from the R register a S scope which is registered with GS;
  c. to system perform the S scope invoking each method of the choreography attached to it. In case of exceptions during the execution of S scope, the user must make the proper decisions on how to continue the execution.

5 Conclusion

The e-government applications has the potential to change public administrations' organization and operation and facilitate the interaction with clients and the interoperability is a key requirement in developing e-government applications, which must change data and information between them. In this paper we presented an approach need, that can be used in designing and developing a distributed network of semantic registries in order to publish, find and execute the Web services.

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