A Semantic Approach to Web Services for Interoperability and Integration of E-Services in Service-Oriented Architecture based E-Governance System

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Abstract—Interoperability and integration among the heterogeneous systems and data sources are tedious job in e-governance due to legacy database, architectures with private networks, limited bandwidth and search capabilities. For these reasons, web service technology is well suited for e-governance system. But the major drawbacks of the web services technologies are their inability to enable automatic discovery, composition, selection of web services and therefore human intervention & effort is required. We propose semantics to the web services through the standard ontology languages Web Service Modeling Language (WSML) to construct machine processable and interoperable. Discovery of services is the key technology in service oriented web software development. How to deploy semantically enriched E-governance web services and how to exploit semantics through web service registries are illustrated. Here we focused on the need of use the semantics in discovering web services in service-oriented semantic web service based e-governance framework. We propose a way to facilitate the issue of discovering the university e-governance services for student clearance certificate that addresses a user need. In this paper, it is also shown how a generic university governance service model can be expressed by means of WSML - a fully fledged logic programming language for describing Semantic Web Services. A novel concept regarding the security of web services is introduce here to protect, authorize, authenticate the propose model in e-governance system.

Keywords—SOA, Interoperability, Web Services, Semantic Web Services, Ontology, WSML, WSMX.

I. INTRODUCTION

Service Oriented Architecture (SOA) in an e-governance domain ensures better reusability, maintainability and flexibility. To achieve this we need to fulfill some key requirements for a SOA based e-governance system, like, interoperability and integration. But due to heterogeneous nature of the system makes this job very difficult. Though using web service technologies we can ensure the availability of interoperability and integrity but at a certain level of heterogeneity and for a limited rigid set of services. They also lack of automatic service discovery, selection, composition, publication etc. to resolve the current state of this problem semantic approach was must specially in a e-governance since it is huge domain to work and due to that they also inherits a larger aspect of heterogeneity introducing a higher level of challenge. Web Services are software modules that describe a collection of operations that can be network-accessible through standardized XML messaging [1]. The emerging concept of Web services is slated to be the backbone of tomorrow’s Web [2]. Adding semantics technologies to the web services solves the said problems of web services. A Semantic Web Service (SWS) is the combination of semantic web technology and web services. Semantic Web Services (SWS) technology [3][4] provides an infrastructure in which new services can be added, discovered and composed continually, and the organization processes automatically updated to reflect new forms of cooperation [5].

Here we propose a model to enrich the web services with semantics by coding ontologies. It is also shown how to deploy them and make ready for execution in semantic execution environment. For this purpose we have chosen a student clearance certificate issuing service from a generic university governance service as a test case. Web Service Modeling Ontology (WSMO) is used to describe the semantics. On the other hand Web Service Modeling Language (WSML) has been selected to develop all the necessary ontologies in our model. Web Service Modeling Execution Environment (WSMX) is embedded in our propose model to execute the semantic for achieving the required interoperability, integrity and automation.

The remainder of the paper is organized as follows: Section-II illustrated the survey of related research works. Section-III depicts the semantic web service based technologies for e-Governance. Section-IV illustrated the role of semantic interoperability in e-governance. An Ontology driven framework for
A lot of literature has paid attention to the phased e-government implementation planning and discussed the essential constituents of e-government integration. Ljiljana Stojanovic and others [6] support how the usage of semantic technologies for describing E-Government services can improve the management of changes. They have extended previous work in ontology evolution, in order to take into account the specificities of ontologies that are used for the description of E-Government services. In order to describe services a markup language (GovML) has been developed [7]. It defines a set of metadata to describe public administration services and life events. The ONTOGOV service ontology [8] is E-government domain-specific service ontology, described by the ONTOGOV IST project. The proposed ontology is heavily based on the two major generic service ontologies, namely OWL-S and Web Service Modeling Ontology (WSMO). WebDG Ontologies [9] have been developed under the Web Digital government (WebDG) project. In this project ontologies were used to organize government information in order to make automatic composition feasible. Zhiqiang Nie [10] proposes a new EGovernment integration model, which integrates a number of ontology and brings forward a new ontology algorithm. He proposes ontology's automatic extraction is a core problem of Information Integration in Electronic Government Affair. Yi Xiao and others [11] apply ontology-based approach to modeling and collaborating E-Government business knowledge Service-oriented middleware base on multi-agent system for e-governance is depicted in [12]. A semantic web service based approach in e-governance using ontology has been discussed in [13]. A knowledge based platform is developed by SmartGov project [14] for assisting public sector employees to generate on-line transaction services.
semantics have been formally described to be discovered, selected, mediated and invoked to carry out specific client tasks. The architecture of the WSMX [21] is given below

![WSMX Architecture](image)

Fig1: WSMX Architecture [21]

D. The Use of Ontologies

Ontology is a computational representation of concepts and the attributes of these concepts and relationship between these concepts. Ontology technology is now increasingly used in E-governance application particularly in the field of information retrieval. A quite suitable definition for ontology described in [22].an Ontology structure is illustrated as in [23]. A={C,R,A0}, Where C is the Concept and RC CXC is a set of relationship. A is set of axioms on O. A concept can be described as an entity or a class with properties and property restrictions.

IV. OBJECTIVE OF SEMANTIC FOR INTEROPERABILITY IN E-GOVERNANCE

Semantics is compelled to provide information, not just data. In other words, semantics introduces meaning into the data in order to allow computers to deal with this information in a more interoperable manner. The aim for this discipline is the provision of information understandable by machines. Enriching the Web services infrastructure with semantics will let Web services i) Explicitly express and reason about business relations and rules. ii) Represent and reason about the task a Web service performs, thus enabling automated service discovery based on explicit advertisements and descriptions of service functionality iii) Represent and reason about message ordering iv) Understand the meaning of exchanged messages; v) Represent and reason about preconditions for using services and the effects of invoking them; and vii) Combine Web services to achieve more complex services.

V. ONTOLOGY-ORIENTED ARCHITECTURE FOR SEMANTIC SERVICE DISCOVERY

Here the conceptual architecture of the SWS based integrated model for developing the e-governance infrastructure as well as the interoperability, integration and sharing of the web services has been illustrated. From the point of theory the model makes the semantic content of web services more clear and perfect and enables computers to understand more accurately.

![Architecture for Service Discovery using Ontology](image)

Fig2: Architecture for Service Discovery using Ontology

Distributed information or service with different description format can be processed more automatically with the assistance of SOAP, WSDL, and jUDDI & WSMX WSMX is an execution environment for the dynamic discovery, selection, mediation, invocation, and inter-operation of semantic web services based on the Web Service Modeling Ontology (WSMO) specification. In Fig-2 an advance framework for semantic service discovery based on ontology is proposed. The framework comes with lots of advantageous sides in terms of interoperability, integration, reuse of data among the heterogeneous system. This framework is self-sufficient to generate the web service automatically by collecting the necessary information from the E-Government legacy databases. A new component, “WS Generator” is introduced in this framework to perform the said task. The jUDDI registry system is used to store and maintain the discovery information of the web services and also their corresponding WSDL files. We added the semantic description into the stored web services to
convert them into semantic web services using WSML for interoperability. WSMO based Semantic Execution Environment WSMX included in this architecture to alleviate the lack of interoperability. In general the WSMX don’t come with any security measures to prevent the threats. We propose a new component “WS Security” with the existing components of the WSMX to solve the security problem. This component will enrich the WSMX environment with advance security facilities internally. An external firewall cum UTM (Unified Threat Management) system is proposed here to protect the intruder. Authentication and authorization of user request will be checked by WS-Security component into the WSMX.

VI. DESIGN & IMPLEMENTATION OF PROPOSE FRAMEWORK FOR SECURITY MANAGEMENT

Here in this paper we describe a novel conceptual framework regarding the security of web services to protect, authorize, authenticate the propose model in e-governance system.

WSDL plays a key role in the web service technologies. A detailed description about the web services can be available to anyone who is searching for the WSDL files. For the sake of security concerns the service providers don’t want to reveal all the important information to all. Service provider can hide the information by encrypting whole WSDL file. But encrypting the whole WSDL file will take off the functionality of the web services. In lieu of that we propose a framework to encrypt some selected fields in a WSDL document. For example suppose a WS comes with some different kind of methods performing some job, among them some are very critical and should not be invoked by the client parties since any adversary can crash the system by illegal execution of the method. The developers of the web services want to hide those methods by encrypting the corresponding fields in the WSDL file with the entry of those methods. Through our propose framework this functionality can be achieved. In our framework an Intelligent Agent (IA) will handle all the incoming messages towards a particular server maintaining all the web services. Actually this IA will act like a gateway to the server and also to the corresponding jUDDI servers. And whenever the web services will response back it will traverse through the agent. The main point is that no direct access to the jUDDI registry and also to the registered web services into that registry and maintaining at some servers. With this approach discovery attacks can be easily prevented. In the said framework a unique security ID will be generated for each web service and by tracking this ID authorized web services can be sorted out.

![Fig3. A Conceptual Framework for Security Management in E-Governance](image)

The concept of this intelligent agent can be adopted in the semantic environment also. That is no direct access to the semantic execution environment like WSMX could be possible without traversing through the filtering agent. This way unauthorized access to the ontologies of the web services could be prevented. With this security agent SOAP messages can be filtered also. So the occurrence of the SOAP attacks could be reduced down.

In Fig.3 the pictorial view of the conceptual framework for security management is shown. All the incoming messages are passing through the IA. Inside the IA, the user (requester) is authenticated first then the request is validated. More simply it is checked that the request is permissible or not and also the user is authorized for such request or not. Then request is send to the appropriate entity and the response is collected back by IA. If required then the necessary filtering module will invoke (for eg. WSDL filter will invoke to hide out the unnecessary information from their requested WSDL file) to perform the required filter, if any. Finally the result is handover to the user.
In the figure no semantic environment is shown, but it is also applicable in the semantic environment.

**B. Building Domain Ontology in WSML**

Domain ontology absorbed the connected domain knowledge, to cater common understanding about the domain knowledge. The model representation in Web Service Modeling Language is the main issue that concerned us. The WSML-Rule language has been selected for the WSML implementation due to their strong expressiveness. The University Governance Ontology (UGO) in WSML has been developed using the Web Services Modeling Toolkit (WSMT). All the related developed web services with their source code and University Governance Architecture (UGA) object model to make the UGO is available in our previous work [24]. This work is the enhancement of our previous work. Due to lack of space a pictorial view of student clearance concepts in UGO ontology is shown in Fig-4. The following ontology is developed from the four web services after adding semantics and utilizes their concepts, attribute.

**VII. PROPOSE DOMAIN-ONTOLOGY-BASED WEB SERVICE DISCOVERY FOR STUDENT CLEARANCE CERTIFICATE**

Here Student Clearance Concept illustrated in WSMT environment to show the relation among the domain and sub-domain of University Governance System.

The goal of domain ontology is to capture the knowledge of related domains, to provide common understanding about the domain knowledge, to determine the terms commonly recognized in this domain, and to well define these terms and the relationship between them from formalized patterns of different levels. Using WSML language we added semantics in all the developed web services. Here it is shown in the Fig-4 the propose goals for desired service discovery. Desire user goal is submitted through the web browser to the WSMX environment for execution to get desired service.

![Image of discovered web service](image1)

**Fig 5: Result of discovered web service (achieved goal)**

There are four web services implemented in our propose University Governance System. It is shown in Fig-8 that the library web services discovered among the four services in WSMX environment. So, it is observed that the desired goal discovered in automatic way from the WSMX repository with the help of its components.

**VIII. A CASE STUDY AND ANALYSIS**

One of the key features of student administration service is issuing the student clearance certificate service, that have been used as the test bed for the propose architecture. The main purpose of the student clearance service is to provide the university students a fast, easy to use service which is a part of university governance System to collect their university clearance. It is generally required at the time when a student is leaving or collecting their final mark sheet from the university.

![Image of running example](image2)

**Figure 6: Running Example**

To collect final clearance we have used our developed domain ontology, web service and goal descriptions in WSMO based semantic execution environment that is
WSMX. The first three services are responsible for providing the corresponding sub clearances (hostel clearance, library clearance, financial clearance etc.) as already stated in the previous paragraph. Student Clearance Service is responsible for taking the clearances from the first three services as piece-of-evidence (evidence proof) and provides the grant/final clearance. In this architecture all semantic descriptions are stored into the semantic knowledge repository. When a user (student) have to get a service they first open the university website where s/he will find a link to the actual GUI for the student administration service which is also a part of the university governance service. This GUI for the student administration is used to take the student’s desires as input which will help to achieve the goal by invoking the proper Web Service/s through the WSMX. Discovery of Web Services, selecting and invoking them is the responsibility of the WSMX by the help of stored semantic descriptions of the Web Services having specific pre and post conditions.

IX. CONCLUSIONS AND FUTURE WORK

In this paper we use the information available using discovery engine as well as semantic methods. Our propose model provides semantic foundation for knowledge sharing, transformation and exchange by ontology. Future work includes rule-based reasoning to simulate the evaluation of state variables for checking that all compositions are consistent with respect to the corresponding business logic conditions.

REFERENCES

[9] B. Medjahed, et al., Infrastructure for Government Web Services, selecting and invoking them is the responsibility of the WSMX by the help of stored semantic descriptions of the Web Services having specific pre and post conditions.


