Semantic Service Oriented Framework for E-Government in Pakistan

Developed by:

Farkhanda Nasim
337-FBAS/MSCS/F07

Supervised by:

Ms. Muneera Bano

Department of Computer Science
Faculty of Basic and Applied Sciences
International Islamic University Islamabad
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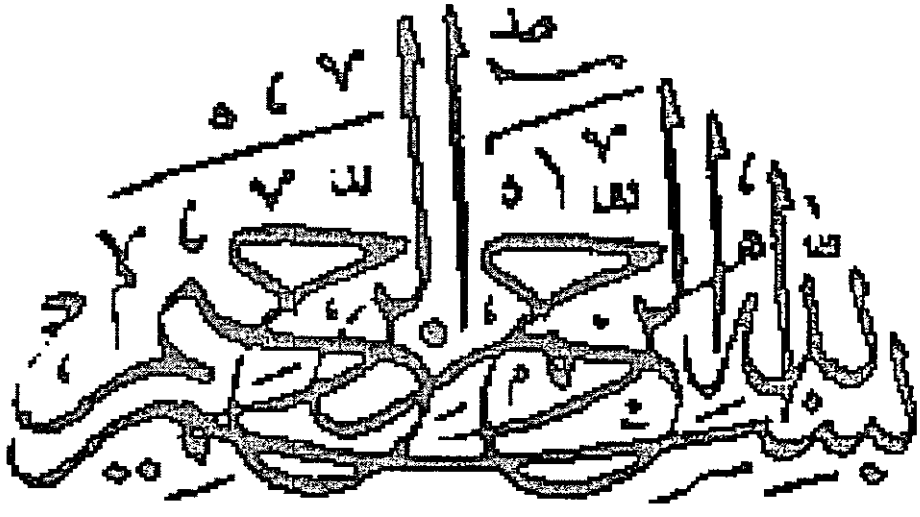

In the Name of ALLAH ALMIGHTY The Most Merciful, The most Beneficent

Department of Computer Science

International Islamic University Islamabad

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Final Approval

This is to certify that we have read the thesis submitted by **Farkhanda Nasim, Registration # 337-FBAS/MSCS/F07.** It is our judgment that this thesis is of sufficient standard to warrant its acceptance by International Islamic University, Islamabad for the degree of MSCS.

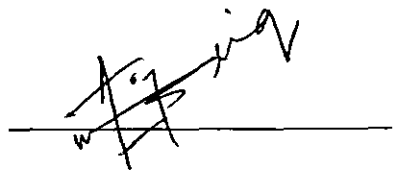
Committee:

External Examiner:

Ms. Amna Tariq

Lecturer

FAST-NU University, H-11/4, Islamabad



Internal Examiner:

Mr. Mata Ur Rehman

Assistant Professor

International Islamic University, H-10, Islamabad

Supervisor:

Ms. Muneera Bano

Assistant Professor

International Islamic University, H-10, Islamabad

Dedication

This thesis is dedicated to my loving parents who gave me courage and strength throughout my studies. They are the source of inspiration for me through all my walks of life.

Finally this thesis is dedicated to my teachers, family and friends who cooperated me during this research.

A dissertation Submitted To

Department of Computer Science,

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As a Partial Fulfillment of the Requirement for the Award of the

Degree of *MSCS.*

Declaration

I hereby declare that this Thesis *"Semantic Service Oriented Framework for E-Government in Pakistan"* neither as a whole nor as a part has been copied out from any source. It is further declared that I have done this research with the accompanied report entirely on the basis of my personal efforts, under the proficient guidance of my teachers especially my supervisor *MS. Muneera Bano* and also Ms. Amna Basharat who guided me in this Research. If any part of the system is proved to be copied out from any source or found to be reproduction of any project from any of the training institute or educational institutions, I shall stand by the consequences.

Farkhanda Nasim

337-FBAS/MSCS/F07

Acknowledgement

First of all I am obliged to Allah Almighty the Merciful, the Beneficent and the source of all Knowledge, for granting us the courage and knowledge to complete this Project.

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Farkhanda Nasim

337-FBAS/MSCS/F07

Project In Brief

Project Title:	Semantic Service Oriented Framework for E-Government in Pakistan
Undertaken By:	Farkhanda Nasim
Supervised By:	Ms. Muneera Bano
Start Date:	November 2008
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Tools & Technologies:	WSMO, WSMT and WSMX
Documentation Tools:	Microsoft Word, Microsoft PowerPoint, Microsoft Visio
Operating System:	Windows XP
System Used:	Pentium IV

Abstract

E-Government is a key instrument for facilitating users with e-services at their easiest level. This filed is getting more attractive as the users are getting more aware of using internet. Due to much data available on the internet, it becomes difficult to discover the correct or required data. Therefore we have addressed the problem of supplying the correct information to the citizens of Pakistan from public administration in quick and easy way.

Main aim is to facilitate the citizens with their required services in less time and cost. Therefore we have focused on E-Government Domain which aims at providing the citizens with their required services in an easy and efficient way. For that we have studied different Web Technologies and also highlighted their advantages and limitations. After studying all the web technologies, we found Semantic Web Service Technology to be the best option to address the problem of getting correct information dynamically.

We have proposed a Framework for E-Government in Pakistan. This framework is based on Service Oriented Architecture using Semantic Web Technology. For having realization of this Framework, we took the domain of Driving License Registration as a test case. Domain knowledge of this registration process is shown by an ontology which is created in WSML (Web Service Modeling Language) showing the main concepts and their attributes. Then we have created the Web Services and Goals in WSML to show the discovery process.

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Chapter 1

Introduction

1. Introduction

1.1 Motivation

E-Government is a key instrument for facilitating users with e-services at their easiest level. This filed is getting more and more attractive as the users are getting more aware of using internet. This technology enables the organizations to fulfill the citizen's needs and provide full access to the public services.

E-Government provides the services to the citizens to accomplish their daily routine transactions like tax payment, license registrations, permits issuance etc. All these tasks which are required by the citizens in their daily routine are provided by the Government as online services. For successful implementation of these public services, they should be built around citizen's needs.

According to Haroon Shahzad and Waqas Younas Sandhu (2007) e-services should be socially inclusive means that citizens should have ready access to all the services and also feel confident while using them. Citizens mostly needs interactions with the public services in the areas of social services and in the field of health where citizens are normally poor, elderly and not in good health. They are normally of lower education and needs assistance for executing these public services.

E-Government is getting more attention because it facilitates the users to access the public services without understanding the complex structures of the Government. Trust relationship can be built between citizens and Government by giving single integrated platform for the citizens from where citizens can easily access all their required services.

E-Government has been established in Developed Countries and these countries are taking great advantage from this technology to facilitate their citizens. European countries are fully utilizing the technology. There is great need of improving E-Government processes in developing countries. Early E-Government processes were non-transactional. Only static information for accessing the Government processes were provided like instructions for getting permits, or online forms for downloading were present. Now these processes are fully transactional, but still developing countries lack fully transactional processes.

Pakistan is also one of the developing countries and lacks fully automated and transactional E-Government. Lots of improvements are required. Now Pakistan also has National Portal at (www.pakistan.gov.pk) which aims at providing public services to the citizens. But still it requires a lot of manual work. Processes are not fully automated, human intervention is required. In this thesis we will present the E-Government framework for Pakistan based on Semantic Web using Service Oriented Architecture to fully automate the process and to enable the automatic discovery, mediation and composition.

1.2 Background

In developed as well as developing countries, E-government is gaining a lot of attention due to its ability to accelerate the processing and to ensure a fast and transparent delivery of the services to the citizens. Therefore in Pakistan also, Federal Cabinet made decision for establishing E-government Directorate (EGD) within the Ministry of Information Technology in 2002. It was mainly aimed at implementing different projects of E-Government, providing technical advice for implementing them, providing efficient and transparent services to the citizens in cost effective manner.

In 2005 EGD prepared the Document: "E-Government Strategy & 5 Year' Plan for the Federal Government". Basic strategy of this plan is as follows

- Deploy the basic infrastructure for all the Government agencies and to connect them all to Federal Government Data Center.
- Common applications of all the Divisions has been identified and then are to be implemented by Ministry of IT.
- Agency specific applications are to be identified.

Therefore this process is still under process. EGD is working on that project. Some of the projects have been implemented and some are under process.

1.3 Current Status of E-Government in Pakistan

In the last few years, EGD have completed many projects and many are under progress. Following is the list of projects completed by EGD as presented in the document "E-Government Strategy and 5-Year Plan for the Federal Government (May 2005)".

1.3.1 E-Government and the National IT Policy and Action Plan 2000

Combining IT and Telecom is a great step taking into consideration the dependence of IT on Telecommunication infrastructure. In 2002 the first IT policy and National IT Policy was approved by the Federal Cabinet and this IT policy focused mainly on the use of IT in Government sector.

1.3.2 Electronic Government Directorate

IT Commission was converted to EGD in October 2002 by the Federal Cabinet approval. It is cell that is to specially focus on the E-Government with some terms of references. It is to bring the E-Government transformation in Federal Government.

1.3.3 Legislation

It is the key component of the IT Program and required for online transactions and reengineering the processes. Information society introduced the new legal challenges for which either the new legislation or the amendment of existing laws is required. Recognition of Electronic transaction is the most fundamental legislation. Electronic Transaction Ordinance has been established in 2002 which already has established the Accrediation Council for the accreditation of certificate authorities.

1.3.4 Projects at the Federal Government of Pakistan

Several Government Projects have been sponsored by Ministry of IT. From the year 2000-2001 till the year 2003-2004, Ministry of IT has utilized just the budget of RS 4.82 billion out of Rs. 370 million due to lack of technology capacity. From 2004 onwards, the Human

Resource Capacity of EGD has increased which directly increased the number of projects being planned by EGD. For details about the projects see the document "E-Government Strategy and 5-Year Plan for the Federal Government (May 2005)".

1.3.5 Ministry of IT

Ministry of IT not only implemented the projects under the Federal Government but it also made the Ministry and its department to use the E-Government. A lot of projects are implemented in this context. For details about the projects see the document "E-Government Strategy and 5-Year Plan for the Federal Government (May 2005)".

1.4 Problem Domain

Today in this busy age, people don't find time to visit the Government offices daily in their office timings to accomplish their routine tasks. They are so busy that they want access to these services in whole week and 24 hours. Therefore this increases the challenge for the E-Government that how to enrich the lives of their citizens by providing easy access to its users.

This is the age of IT and now more and more people have access to web in their homes, offices and businesses. Therefore citizens want these services at their homes, offices without visiting the Government offices and without understanding the complex structures of the Government. So, it is a big challenge for the E-Government to understand that citizens wants what services and how and when. E-Government basically aims at improving the way how citizens and businesses interact with the Government.

As it is said by Haroon Shazad and Waqas Younas Sandhu (2007) that nowadays people have more demands for their time and money. Manual work of the Government costs very high then that of electronic transactions. Manual work cost more in terms of technical staff hiring, staff timings and more paper supplies. These Government offices transactions are costly in terms of time also, as computing time and distances are increased. Therefore customers want these services in less time and at time which is convenient for them like after office timings and in their holidays.

Realizing the need of E-Government, Pakistan has also established e-Government Directorate (EGD) under the Ministry of IT. For that purpose National Portal of Pakistan is trying to provide the single integrated platform for the citizens of Pakistan from where they can get their required services. But still that portal lacks in many aspects. Lot of work is required to fully automate the E-government processes.

As the main purpose of E-Government is to provide the services to the citizens at their doorstep at their easiest level, therefore it is required to provide the users with single integrated platform from where citizens can have all the services of Government. This needs interoperatability and interaction between different businesses which is a big challenge for E-Government. To meet this challenge, along with the need of developing new eGovernment solution, there is also a need of reusing the existing services and systems for integration. Service Oriented Architecture is a new technology which overcomes the problem by defining the functionality of business processes as discrete services which are accessible to its users through well defined interfaces. Service Oriented Architecture is a technology that is used for integration and reusability. Distributed systems have some of the characteristics of SOA, however they are highly complex, therefore nowadays web services technology is used for SOA. Web Service is basically a program or software distributed over the internet and easily accessible over standard internet protocol via a web interface. But according to Andrej Holubek (2007) Web Services have some deficiencies:

- They have syntactic descriptions, Traditional web service technologies lack semantic description.
- Dynamic service discovery, composition and invocation is not performed because they need human interaction.
- Scalability is difficult.

Therefore to overcome these deficiencies Semantics are needed to be added in the information which is called as Semantic Web Technology.

Semantic web is clearly defined by Berners-Lee et al. (2001) as:

"The Semantic Web is an extension of the current Web in which information is given well-defined meaning, better enabling computers and people to work in cooperation."

As Semantics are used to overcome the deficiency of Syntatic Web but still it has a deficiency that it is static. So nowadays a new Technology Semantic Web Services is used which overcomes both the deficiencies by combining Semantic Web and Web Services Technology.

So in developing countries like Pakistan, there is a great need of implementing this technology in E-Government to make the process fully transactional and automated. Semantic Web based Frameworks are very rare around the whole world and Pakistan also have not done any work in the field of Semantic Web based Framework at National Level. There is a great need of Semantic Web Services Framework for properly implementing the E-Government in Pakistan.

1.5 Proposed Architecture

We have proposed the Semantic Web based Service Oriented Architecture architecture for E-Government in Pakistan. There are many models for implementing Semantic Web, we have used WSMO as the basic model of Semantic Web. Dumitru Roman et al. (2005) explains WSMO as conceptual model for providing all the descriptions of services through web service interface. Goal of WSMO is the automation of discovery, selection, composition, mediation and invocation. WSMF is the conceptual base of WSMO and WSMO extends this framework by the use of ontologies and languages. WSMX is basically an execution environment of WSMO which enables the service discovery, selection, mediation, invocation and interoperation of Semantic web services.

We have proposed the architecture of E-Government of Pakistan using WSMX components for Sevice Registration, Discovery, Invocation. We have implemented one of the Processes of Government that is Driving License Registration Process as a test case.

1.6 Thesis Outline

Section 2 contains the Literature Review. In that section current Web Technologies are briefly explained, their advantages and deficiencies are also explained. After explaining the deficiencies of current Web Technologies, new Web Technology *"Semantic Web Services"*

is explained. Its basic Model *"WSMO"* and Implementation Tool *"WSMT"* are Explained. It is also explained that how E-Government framework can be implemented using Semantic Web Service Architecture.

Section 3 explains the Requirement Analysis. First of all the need for E-Government Framework in Pakistan is explained. Then requirement analysis of using Semantic Web Services for implementing E-Government framework in Pakistan is given.

Section 4 gives the System Design. In that Section our proposed E-Government Framework is given which is based on Service Oriented Architecture using Semantic Web Service Technology. Then elaborated Framework is given which shows the Service Registration, Discovery and Invocation Process using WSMX components.

Section 5 gives the details of Implementation. Driving License Registration Process in Pakistan is explained. Then this process is mapped with the concept of Web Services. And it is shown that how this process can be implemented using Semantic Web Service Technology. Details of Ontology, Web Services and Goals coded in WSMT are given.

Section 6 concludes the Thesis. Achievements are explained along with the improvements and Future Recommendations.

Chapter 2

Literature Survey

2. Literature Survey

2.1 Introduction

E-Government is a way to deliver the services to its consumers which includes the citizens, organizations and businesses. As presented by the Document "E-Government Strategy and 5-Year Plan for the Federal Government (May 2005)" the scope of E-Government in the context of Federal Government of Pakistan is defined as the

"combination of internal e-enablement and the external provision of e-Services to stakeholders of the Federal Government".

Following Figure clearly shows the scope of E-Government in Pakistan.

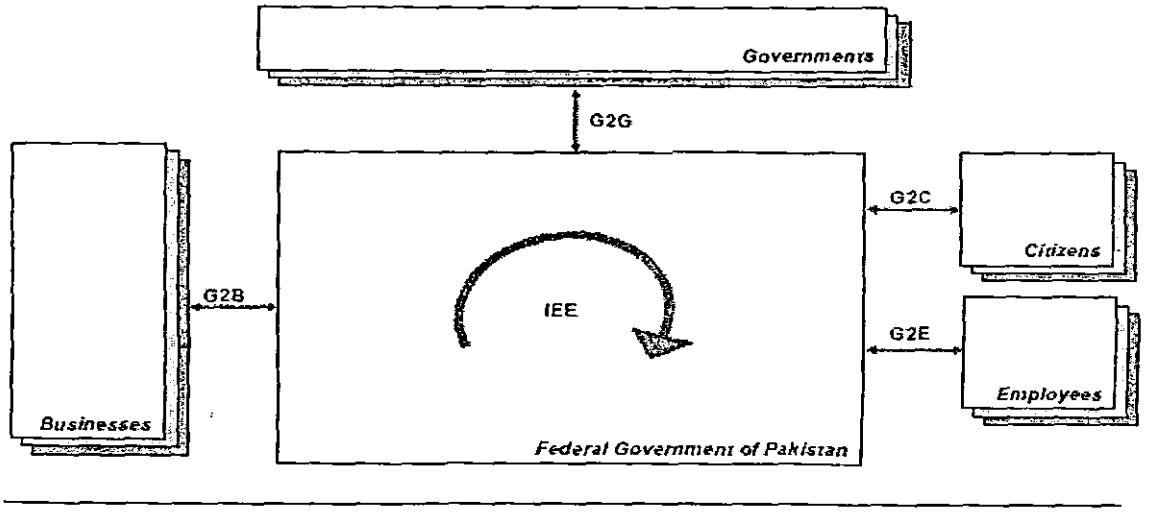


Figure 2.1 Scope of E-Government in Pakistan

G2G stands for Government to Government that includes the federal, local, provincial as well as Government of other countries. G2B stands for Government to Business that includes all the suppliers and Businesses. G2C stands for Government to Citizen that includes the citizens of Pakistan that facilitates the users in providing the easy to use services. G2E stands for Government to Employee that includes all the Government Employees. IEEE stands for Internal Efficiency and Effectiveness that includes the use of modern technology to improve the quality and reduce the costs of the federal Government.

Basic purpose of E-government is to provide the ease and satisfaction to its citizens and other consumers to meet their needs. To provide ease, it is required to provide the users with single integrated platform from where citizens can have all the services of Government. This needs interoperatability and interaction between different businesses which is a big challenge for E-Government. To meet this challenge, along with the need of developing new eGovernment solution, there is also a need of reusing the existing services and systems for integration. Service Oriented Architecture is a new technology which overcomes the problem by defining the functionality of business processes as discrete services which are accessible to its users through well defined interfaces. Service Oriented Architecture is a technology that is used for integration and reusability.

With the rapid development of Web Services, Service Oriented Architecture (SOA) gained more attention as SOA is usually implemented through Web Services. However it is claimed by M. Zeeshan Ali Ansari and M. Imran Khan (2008) that Web Services can't fully accomplish the goal of seamless integration due to some limitations. Due to the lack of some characteristics, Web Services are unable to overcome the limitations like lack of robustness, scalability and reliability. One of the major backdraw of this technology is the manual discovery and invocation of the services.

Adrian Mocan et al. (2006) gave an argument that these limitations can be overcomed and the benefits of SOA can be enhanced by adding Semantics into SOA. Semantically enabled Service Oriented Architecture can manage the flexible and dynamic business interactions. In Semantic SOAs, semantics are used to represent the services offered by the service providers and the capabilities needed by the service consumers. For managing Semantic Service Oriented Architecture, WSMX is a framework for managing all the aspects of Semantic SOAs.

For successfully implementing E-Government framework, SOA implemented through Semantic web services technology is needed. We have explained all these technologies later in this chapter to get the full understanding of the process of implementing E-Government framework using Semantic Web Service Technology.

This chapter is structured as follows: Section 2 briefly explains the Service Oriented Architecture, its technologies and benefits. Section 3 explains the Web Services Technology and its limitations. Section 4 illustrates the Semantic Web Technology and Semantic web

languages. Section 5 introduces the Semantic Web Services Technology which is the intersection of Web Service and Semantic Web. This section also gives the comparison between these web technologies. Section 6 illustrates the WSMO and its major components. This section also explains the WSMX which is a framework for implementing Semantic SOAs. Section 7 briefly explains the E-Government and Section 8 defines the basic model for E-Government processes that is GEA PA service Model. Section 9 finally gives the conceptual mapping of GEA Model and WSMO.

2.2 Service Oriented Architecture

SOA is basically an architecture which is used to build an application which uses the available services from the web. Services are the main building blocks or infact the central pillars of this architecture. Services are explained by Tao Zhang et al. (2006) as the working units made by the Service Providers to fulfill the needs of the service requesters . These services are accessible through well-defined interfaces. SOA architecture basically gives the way to access and discover these services. These are considered as central pillar because users are more concerned about the services for completing their processes. SOA is usually implemented through Web Services Technology.

There are mainly three types of service components: Service Provider, Service Consumer, Retailer. Following figure is showing the traditional discovery and subscription method of SOA.

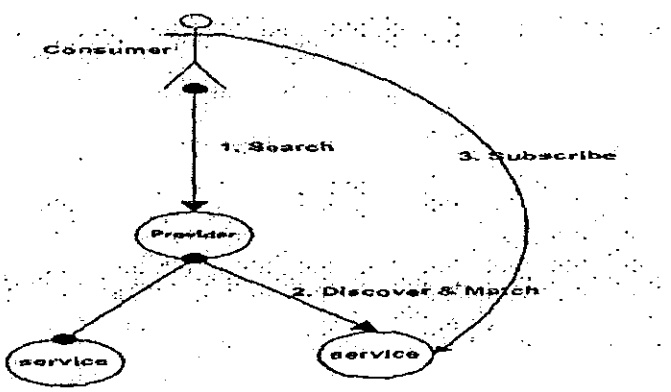


Figure 2.2 Service Oriented Architecture

SOA increase the reuse of the software and integration issues. Distributed systems have some of the characteristics of SOA, however they are highly complex, therefore nowadays web services technology is used for SOA. Web Service technology is explained later in this chapter.

2.2.1 SOA Technologies:

SOA Technologies are briefly defined in this section

2.2.1.1 SOAP

"SOAP" stands for "Simple Object Access Model". It is basically a messaging framework in which messages are sent through tag based language i.e, XML. SOAP Protocol supports both messaging patterns that are synchronous and asynchronous but most common is synchronous.

2.2.1.2 WSDL

"WSDL" stands for "Web Service Description Language. This language basically gives the description of services and their messages in XML based Way, thus supporting rich and hierarchical data types.

2.2.1.3 UDDI

"UDDI" stands for "Universal Description, Discovery and Integration". It basically works as registry, where services along with their description can be registered in XML based way and then can be searched. SOAP is used to access the registry.

2.3 Web Services

Web Service is basically a program or software distributed over the internet and easily accessible over standard internet protocol via a web interface. It is reusable and add new level of functionality over the existing web. It changes the static web pages to dynamic environment. Web Service is properly defined by W3C Web Services Architecture Working Group in 2002 as:

"A *software application identified by an URI, whose interfaces and bindings are capable of being defined, described and discovered as XML artifacts. A Web service supports*

2.4 Semantic Web

World Wide Web gave access to the data available anywhere on the internet, but due to popularity and vast use of internet, amount of data on the internet increased tremendously. So, there comes a problem of getting correct and accurate information. Current search engines like google relies on keyword search due to which accuracy level is very low because web pages containing these key words are retrieved and pages that contains the contents of desired topic but not containing these key words are ignored. Due to which web encountered some tremendous changes like ***web service technology*** and ***semantic web technology.***

Semantic web technology extends the syntactic web by adding semantics (logical description of their meaning) in the information. These descriptions are machine processable formalized in the form of ontologies. Semantic web is clearly defined by Berners-Lee et al. (2001) as:

"The Semantic Web is an extension of the current Web in which information is given well-defined meaning, better enabling computers and people to work in cooperation."

2.4.1 Ontologies

Ontology is called as formal domain model that describes the meaning of information. Studer et al. (1998) gave the definition of ontology as:

"An ontology is a formal, explicit specification of a shared conceptualization."

Marta Sabou (2006) says that ontologies should enhance the communication between humans. They represent the information in the machine processable format to facilitate the communication between human and computer or between two computer programs. Ontologies are made by defining set of concepts and relationship between those concepts.

2.4.2 Ontology Languages for Semantic Web

Nowadays there are several formal languages for describing Semantic Web. As described by Marta Sabou (2006) they are ***RDF*** and ***OWL***.

RDF describes the resources on the Web. RDF Schema describes the definitions of basic elements of ontology like classes, their hierarchy, their properties and range but this is not very expressive for describing Semantic Web Applications.

OWL is the ontology language that is more expressive than RDF. Basis for OWL is DAML+OIL (that aimed to overcome the expressivity issue of RDF). It uses the XML syntax to describe the proper relations between classes and encode ontological knowledge.

2.5 Semantic Web services

To overcome the deficiencies of traditional web and web services then comes semantic web service technology. This technology overcome the syntactic and static problems and works dynamically on the basis of semantics. It is a first steps towards the seamless integration of software component. It is the intersection of Web Services and Semantic Web technology. Dumitru Roman et al. (2005) gave argument that although current web technologies also support integration of software components but still they require a lot of interaction with humans which ultimately limits the scalability. Humans have to manually discover and compose web services.

Andrej Holübek (2007) presented the comparison between these technologies.

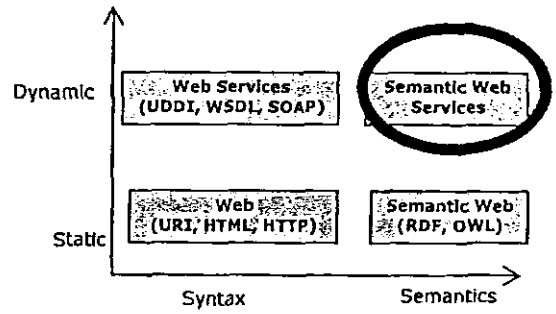


Figure 2.4 Comparison of Web Technologies

Semantic Web Technology has machine readable data. This technology provides the data in the form of ontologies. Ontologies are the diagrammatic representation of the relationship

between different entities. This technology emerged in the result of the combination of semantic web technology and web services technology.

2.5.1 Semantic Web Services (SWS) Activities

Andrej Holubek (2007) presented list of support activities for SWS.

- Publication:
  - Service provider publishes the service descriptions
- Discovery:
  - Locate the suitable services
- Selection:
  - Select the appropriate service
- Composition:
  - Combine the descriptions of the services to achieve goal
- Mediation:
  - Solve the mismatches (syntax, communication)
- Execution:
  - Invoke the services

During last few years Semantic Web technology is progressing very fast. There are a lot of modeling attempts made to have the service descriptions of services in a formal way (e.g WSMO, OWL-S, WSDL-S, METEROR-S). In the next section WSMO and its components are explained.

2.6 Web Service Modeling Ontology (WSMO):

WSMO is explained by Dumitru Roman et al. (2005) as a conceptual model for providing all the descriptions of services through web service interface. Goal of WSMO is the automation of discovery, selection, composition, mediation and invocation. WSMF is the conceptual base of WSMO and WSMO extends this framework by the use of ontologies and languages.

2.6.1 Top Level Elements of WSMO:

Dumitru Roman et al. (2005) expalined the four top level elements to define semantic web services.

- **Ontologies:**
  - They focus on syntactic aspects and allow formal specification that are machine processable. Ontologies constitutes of following elements.
    - **Non Functional Properties:** N'on-functional aspects are described like creator, creation date, natural language description.
    - **Imported ontologies:** Rather than making new ontology, existing ontology can be imported if same functionality is required. Every top-level entity of WSMO can use this facility. Importing ontology can use all the statements of the imported ontology.
    - **Used Mediator:** To resolve the mismatching conflicts between the imported and importing ontologies, mediators are used. They can rename the concepts or attributes. Like ontologies all the top-level elements of WSMO can use mediators. For Ontology element ooMediator (Object Oriented Mediator) is used.
    - **Concepts:** They are the basic elements of some problem domain. Members of concepts are Instances. Attributes are used to describe the Instances that have name and type. Each concept can have some concepts that can serve as super concepts for other concepts. Sub concepts inherits all the attributes of Super concepts. Logical expressions are used to describe the concepts.
    - **Relations:** Relations describe the dependencies between different concepts. Like concepts, relations also have sub-relations that inherits all the properties of super relation.
    - **Functions:**
    - **Instances:** They are the members of Concepts. They have attribute value which have range.

- **Axioms:** These are considered to be the logical expressions.

➢ **Web Services:**

- Web services provide access to the services on the web which in turn returns some value in the domain. It comprises of capabilities which describes the functionality of web services, interfaces describes the choreography and orchestration of web service and internal working of the services. For interaction with the services, web services can use different model, one of which is WSDL. A semantically well defined web service can be processed without the human intervention fulfilling the objective of automating the whole process including the discovery, selection, composition, mediation and invocation. Actually user's goal can be achieved by web services. Following are main elements of Web Service.
  - **Non Functional Properties:** These are the aspects which are not related to the functionality of Web Service. They normally include accuracy, financial properties, Qos(Quality of Service), owner, performance, reliability, security etc.
  - **Imported Ontologies:** Ontologies are imported to describe the vocabulary used in specification of web services. Web services uses mediators also in different conditions.
  - **Capability:** Capability describes the functionality of web services and used for discovery and selection purpose by user. There are many elements of Capability: Non Functional Properties, imported ontologies and used mediators which are described above. Other elements are:
    - **Shared Variable:** Variables shared between preconditions, postconditions, assumptions and effects.
    - **Preconditions:** These conditions specify the required state of information of the web service before execution.
    - **Assumptions:** Specify the state of the world of web service which is assumed before execution. Difference between

Preconditions and Assumptions is that assumptions are not checked necessarily by the web service.

- **Postconditions:** These conditions specify the guaranteed state of information of the web service after execution.
- **Effects:** Specify the state of the world of web service which is guaranteed after the execution.

- **Interfaces:** Describes how the functionality of the web service described by the capability can be achieved. They are also used for discovery and selection purpose. There are two operational views in interface.
  - **Choreography:** How the web service achieves it's capability by doing interactions with users. It is called as communication.
  - **Orchestration:** How the web service achieves it's capability by using other web services. It is called as cooperation.

Following figure contains the basic components of web service.

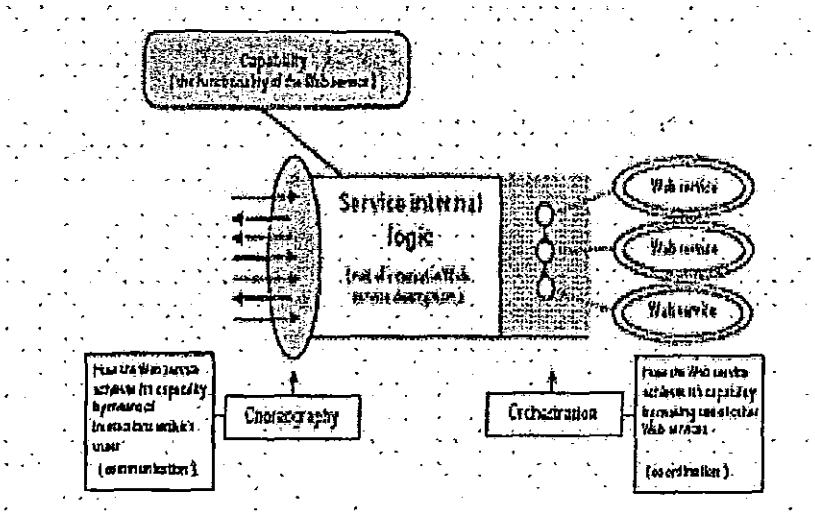


Figure 2.5 Components of Web Services

➢ **Goal:**

- These are the user's desires according to required functionality. Here also ontologies are used to model these requirements. Goals can be resolved by the selecting the best available service. Goal also has elements like Non

Functional Properties, imported ontologies, used mediators, interfaces and capabilities as described above but only in user perspective.

- **Mediators:**
  - They handle interoperatability problems between different components of WSMO. They resolve the mismatches between two entities. There are two levels of mismatches: data level and process level. Mismatch of syntax is data level and mismatch of communication that how to communicate between two web services is process level.

2.6.2 Language of WSMO:

Jos De Bruijn et al. (2008) explains WSML as a formal language for describing semantically the web services, goals, ontologies using WSML variants. It is based on WSMO model and has normal human readable syntax. Following figure shows the WSML Variants:

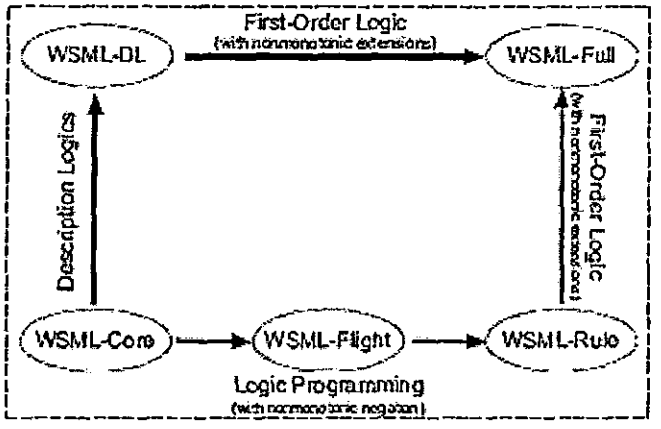


Figure 2.6 WSML Variants

Main variants of WSML are

- WSML- Core
- WSML- DL
- WSML- Flight
- WSML- Rule
- WSML- Full

2.6.3 WSMX

WSMX is basically an execution environment of WSMO which enables the service discovery, selection, mediation, invocation and interoperation of Semantic web services. WSMX processing includes multiple steps which comprises of building a conceptual architecture, defining semantics, developing the architecture, designing and then implementing the system. It is a reference implementation or testing bed for WSMO. It can be fully described by describing the aggregated functionality of its component.

Description of Components of WSMX as described by Maximilian Herold (2008):

a) Core Component:

All the components are controlled by this central component called as Core Component. It is responsible for coordinating the interactions between all the components of WSMX.

b) Resource Manager:

This component manages the repositories containing the descriptions of Web Service, goals, ontologies and mediators. This component is the entry point of all the repositories. No one can perform any operation on these repositories without accessing or invoking the Resource Manger.

c) Service Discovery:

Service Discovery is very important part of Semantic Web Services. It is the process of finding the web service according to users Goal. This process comprises of three basic steps: Goal Discovery, Web Service Discovery, Service Discovery.

Goal Discovery is actually the process of making the user goal a formalized Goal. Web Service Discovery locates the web service according to that formalized Goal. Service Discovery then locates the actual Service that can fulfill the requester Goal. Service Discovery has three approaches: keyword-based Discovery, Lightweight Semantic Discovery and Heavyweight Semantic Discovery.

In keyword Based discovery approach, Keywords of Goal Description and Service Description are matched. Lightweight Semantic Discovery considers the Postconditions of Goal and Service. Heavyweight Semantic Discovery considers the inputs and outputs also along with Postconditions of Goal and Services.

d) Service Selection:

Service Selection component returns the best or the optimal semantic web service to the requestor. Selection criteria may range from simple to more multi-criteria selection, which may include the interaction with user. Selection parameters may include no-functional properties such as quality of service, security, reliability or financial properties.

e) Data and Process Mediator:

Mediation is necessary where there is a mismatching of communication patterns between two entities or they might use different syntax or semantics of data. Data mediation considers the semantic similarities for mediation and Process Mediation adjust the mismatched patterns in order to facilitate the communication between two parties.

f) Communication Manager:

It lies between service provider and requestor and supports the communication in both directions using its two subcomponents: invoker and receiver.

g) Choreography Engine:

This component describes the way that how user can interact with it. Communication patterns of requestor and provider are different so, this component works in correlation with Process Mediator to overcome the mismatch patterns between requestor and provider.

h) Web Service Modeling Toolkit:

This is a framework where all the tools related to Semantic Web Service are deployed. It encourages the developers to develop the tool and then it deploy all these tools at central application, so the users can manage Semantic Web Services by installing only the single application.

i) Reasoner:

It is used to find the capabilities that exactly matches the Goal or subsuming the goal.

2.7 E-Government:

As government is facing the pressure of improving their performance and providing services to the citizens in easy way, E-Government is getting a lot of attention these days. E-Government is getting attractive more and more because of its ability to fulfill the citizen's

needs. Haroon Shahzad & Waqas Younas Sandhu (2007) claims that E-Government provides the e-services to the citizens to facilitate them, so that they can easily interact with the Government and accomplish their tasks without visiting the Government offices. For making the E-Government process more effective, it is necessary to properly understand the user's needs and expectations from the Government. Unique and standard interface should be provided to the citizens for all the processes of Government.

Demand of E-Government is increasing day by day due to many reasons. As this is the era of technology and users are getting more aware about internet usage therefore their demand of getting their services online is increasing. Secondly in this busy age people don't have time visit the Government offices in their office hours so, they need 24 hour services in whole week. Government is expected to provide the users with ready access to their required services. This introduces the big challenge to the Government.

Most common e-services required in Pakistan as explained by Haroon Shahzad & Waqas Younas Sandhu (2007) are in the areas of health and social services where users are elder, in poor health and less educated. They need assistance for accomplishing their tasks.

Many attempts are made in PA (Public Administration) for modeling features of domain, among them is the GEA (Government Enterprise Architecture) Model.

2.8 GEA PA Service Model

GEA Model introduced by V. Peristeras & K.Tarabanis (2004) is explained as the basis for all the E-Government processes. It is hirerical representation which covers the overall domains of E-Government.

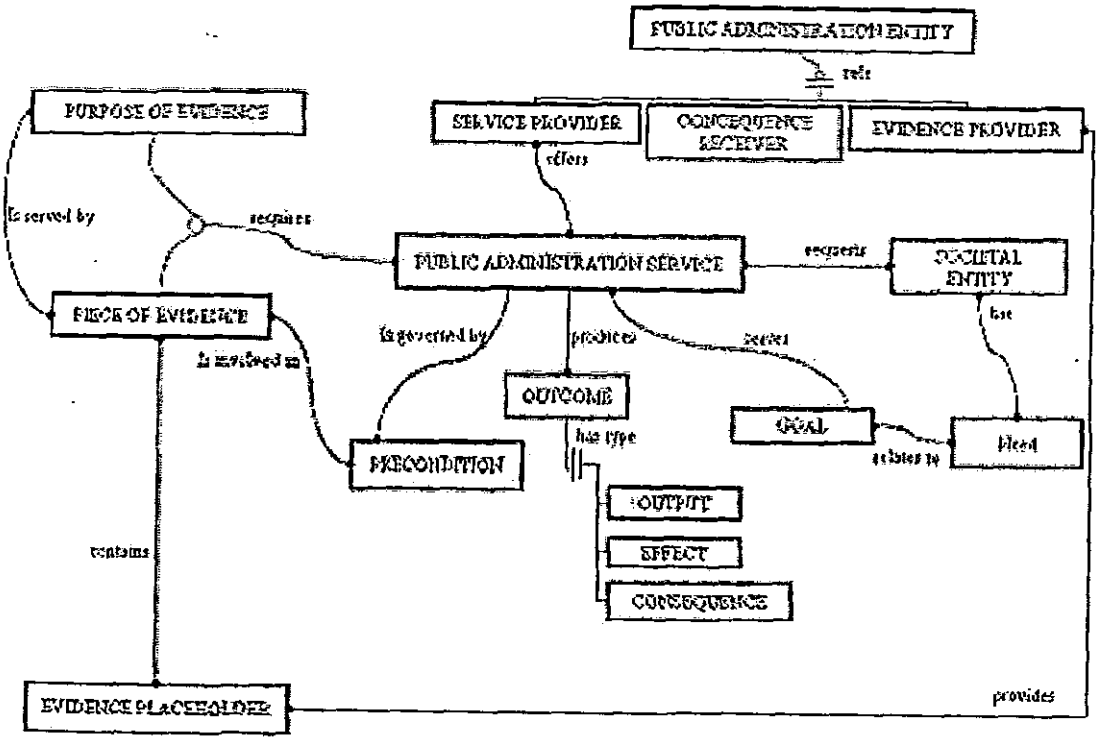


Figure 2.7 GEA PA Service Model

2.9 Conceptual Mapping of GEA PA Service Model and WSMO

It is claimed by Vassilios Peristeras et al. (2007) that before that no efforts are made to connect the two modeling streams of work that are GEA PA Model and WSMO and there is a need of conceptual mapping between these two modeling efforts.

These are the two distinct Models at same level with some important differences. WSMO generally defines the web service and used for formalizing the specific concrete domain using formal language WSML. Whereas GEA is a domain oriented model applicable to PA Service only and doesn't use any formal language for that.

Work presented by Vassilios Peristeras et el. (2007) aims at describing this GEA PA Model using WSMO and WSML language. In this work it is checked that whether GEA PA Service model is compatible to WSMO Model and whether WSMO is enough to describe the details of GEA PA Service Model, how to combine the various aspects of WSMO to accommodate the descriptions provided by GEA.

Following figure presented by Vassilios Peristeras et el. (2007) shows the conceptual mapping of GEA PA and WSMO Model.

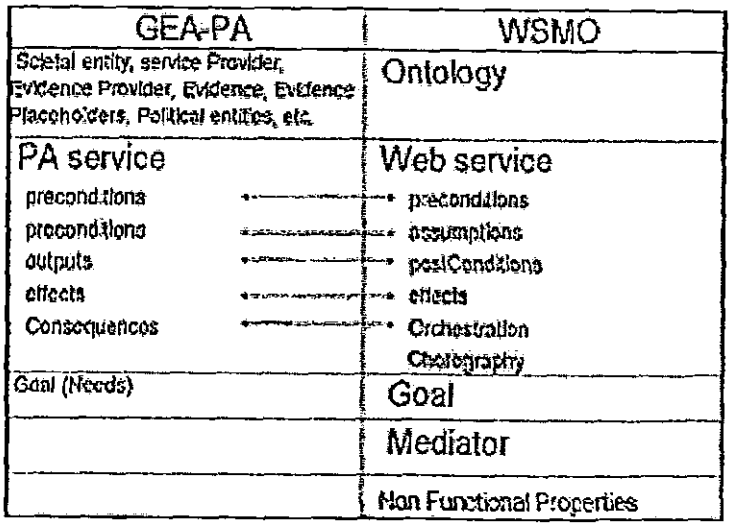


Figure 2.8 Conceptual Mapping of GEA PA and WSMO Model

2.9.1 WSMO Goal

WSMO Goal and GEA Goal both represents the user's requirements, so it is easy to map goals of both Model. But Need concept is informally described in GEA therefore there is no correspondence of GEA Need Concept in WSMO. It is assumed in WSMO that this informal description of Need concept will be transformed to formal goal before executing the semantics. Both these models represents the two views: user's view and service view, whereas other service ontologies like OWL-S don't represent user's views therefore WSMO is more appropriate for the implementation of Semantic PA service Model.

2.9.2 WSMO Service

PA Service entity in GEA Model is related to Web Service concept in WSMO. The goal of representing PA Service with WSMO Web Service is to describe PA Service semantically using WSML Language and making it executable in Web Service Execution Environment like WSDL or WSMX etc.

GEA Preconditions should be modeled by WSMO allowing the input as information as well as constraint on that input. Actual evidence of PA is provided in WSMO by service Choreography interface and the verification of evidence is done in WSMO by Orchestration interface.

The effect notion represents the same concept in both the models. WSMO Postconditions represents the same concepts as GEA output.

2.9.3 WSMO Mediator

This concept doesn't exists in GEA PA Model. They are used to overcome the data and process mismatch between heterogenous ontologies but they don't have any conceptual meaning.

2.9.4 WSMO Ontology

Three ontologies are must to be developed in PA Environment.

- **Law Ontology:** This model GEA Law object and used to extract the service pre-conditions.
- **Actors Ontology:** This ontology includes concepts like Service Provider and Evidence Provider. As the information related to Actor is very crucial therefore this should be modeled as WSMO Ontology in WSMO Web Service Description.
- **Evidence Ontology:** This includes concepts like the Evidence, Evidence Placeholder, Evidence Purpose.

2.10 Summary

In this chapter we defined briefly many Web Technologies and showed how they are used for information integration. Current Keyword search fails to give the correct results because it is based on the information that is available on static web pages and don't perform any data processing logically. To overcome these deficiencies, there are two web technologies. One is Semantic Web which gives the formal description of the meaning of the web pages and data becomes machine processable which enhances the searching tasks. Second one is Web

Services technology that makes the processing of the services dynamic and accessible via web interfaces, but still it also has deficiency that discovery and integration of web services is not dynamic. Therefore to overcome all these limitations of the Web technologies, nowadays Semantic Web Services Technology is getting much attention. It is the intersection of these two technologies: Semantic Web and Web Services. It semantically describes the capabilities of the web services.

As main aim of our thesis is to propose a framework for E-Government of Pakistan, therefore we have used Semantic Web Technology to enhance the capabilities of E-Government. In this chapter we reviewed all these web technologies and mainly the Semantic Web Services Technology along with its basic model WSMO. Then the basic model of E-Government is described to understand the general mechanism of E-Government. Finally we reviewed how both these models can be mapped logically in order to fully utilize the Semantic Web Services Technology for E-Government Framework.

Chapter 3

Requirement Analysis

3 Requirement Analysis

3.1 Need of E-Government Framework in Pakistan

E-Government is one of the biggest Domain having many users. Basic purpose of E-government is to provide the ease and satisfaction to its citizens and other consumers to meet their needs. Therefore after the advancement in information and communication technologies, interaction of citizens with Government is also increased. E-Government sector is getting much attention these days around the whole world and same is the case with Pakistan. To provide ease, it is required to provide the users with single integrated platform from where citizens can have all the services of Government. Pakistan lacks in this direction as it has a national portal to provide the citizens with their required services but not yet fulfilling the actual purpose of providing single integrated platform from where the citizens can accomplish their tasks.

Based on the analysis we have extracted some basic requirements/needs that should be fulfilled in public sector. As it is argumented by Arnold van Overeem, Johan Witters and Vassilios Peristeras (2007) that Public Sector is the combination of diverse organizations having different sizes: Central Government Departments, Agencies, Local Authorities and Health Trust. One of the need is interoperatability and interaction between different businesses which is a big challenge for E-Government. If there is no integration mechanism then it would be very difficult for the clients to understand that which services can be obtained from which administration. So inter-organizational collaboration becomes a necessary part of commercial practice. This whole collaboration process should be transparent to satisfy the ultimate client's needs.

To fullfil the need of interoperatability and collaboration, E-Government Framework needs to be based on Semantic Web Services. So we have proposed a framework based on this technology for the Government of Pakistan.

3.2 Requirement Analysis of Semantic Web based E-Government Framework

We have studied Semantic Web Service Technology and explained in our thesis that how this technology can be applied to E-Government and what are the benefits of using this technology. We have also studied the basic requirements for semantic modeling that should be fulfilled to have successful implementation of Semantic Based E-Government Framework.

Ontologies are the basic mechanism for semantic modeling of goals, sub goals, services and other concepts from the public administration sector. These ontologies are basically the knowledge representation mechanism that model the real world concepts. For implementing these ontologies, there is a need to select a conceptual model. In our thesis, we have used WSMO Framework.

Marta Sabou (2006) explained some basic needs for the creation of ontologies. One is them is the identification and analysis of the diverse needs of citizens. Secondly these needs should be analyzed with respect to information quality properties: scope, relevance etc. These steps produces the normal text descriptions. After that designing of these ontologies is required which contains the definition of relationships between different terms in a formal way. In our thesis, we have used WSML as a formal language.

As we have tested our proposed framework by implementing Driving License Registration Process in WSMT. We have designed the basic ontology of this process in WSML using WSMO Framework.

Chapter 4

System Design

4 System Design

4.1 Conceptual Architecture of E-Government in Pakistan

Our Conceptual Architecture for E-Government processes has the following main components:

4.1.1 N2S Converter:

- This is Need to Service Converter. This logical component takes needs from user and convert it in the form that can be used for discovering the services.

4.1.2 PA Service Repository:

- This is the Directory where all the Web Services are stored.

4.1.3 Web Service Ontology Server:

- Manages the PA domain Model.

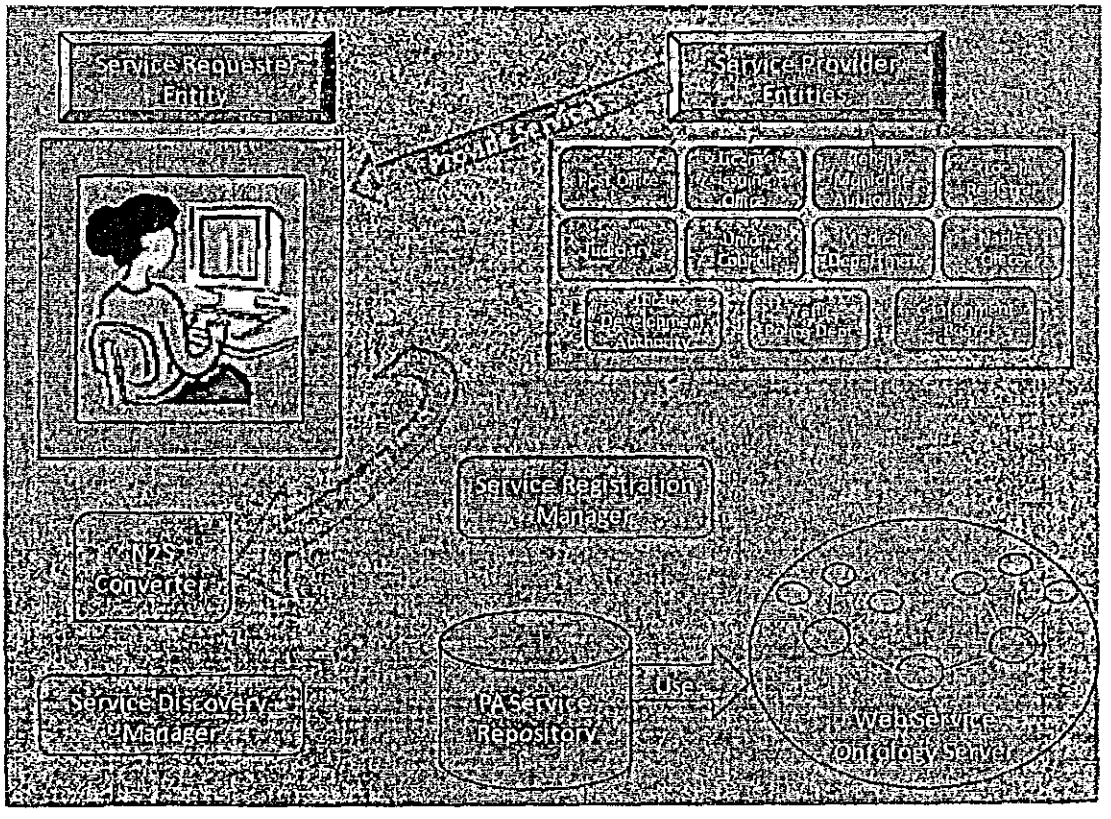


Figure 4.1 Conceptual Architecture of E-Government

Service Providers provides services to the requesters by registering the services in PA Service Repository. Requester first of all specify his needs which are taken by N2S Converter which is a middleware between Service Requester and PA Service Repository. This middleware takes input from the user and convert it into some format that is recognizable by the machine for discovering services from PA Service Registry. This Web Service Registry uses Web Service Ontology Server where all the Ontologies of PAs are available.

4.2 E-Government process automation using WSMX Components

As above given Conceptual Architecture is very generic so gives very top level overview. Below is the architecture which maps the above conceptual architecture with WSMX components. It gives the overview of process of Web service Registration, Web Service Discovery and Web Service Invocation.

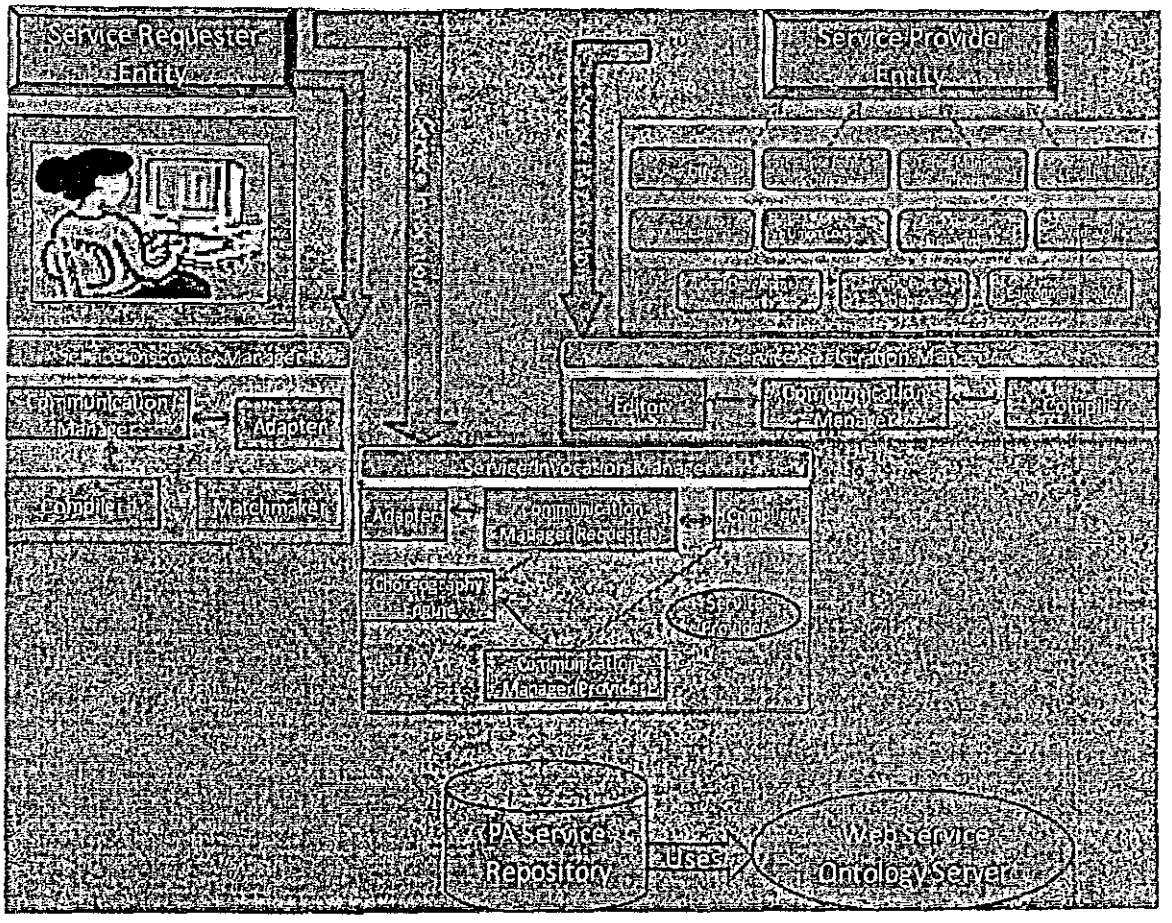


Figure 4.2 E-Government Process Automation using WSMX Components

4.2.1 Service Registration Process

There are four components of WSMX involved in Service Registration Process: Editor, Communication Manager, Compiler and Service Directory. Process of Service Registration explained by Robert Zaremba (2007) is as follows:

Web Service WSML Description is given by Service Provider which is defined in editor, Compiler checks the syntax of the WSML Document and then this document is added to the repository.

4.2.2 Service Discovery Process

There are five components of WSMX involved in Service Discovery Process: Adapter, Communication Manager, Compiler, Match Maker and Service Directory. Process of Service Registration explained by Robert Zaremba (2007) is as follows:

Service Requester sends the request which is converted by Adapter into a WSML Goal. Communication Manger handles the invocation. After that Compiler checks the syntax of the Document. Matchmaker actually performs the Discovery Process. It selects the service from Service Repository according to the defined Goal, using Data Mediator if some conversion is required. The Web Service that best matches the Goal is returned to the Service Requester.

4.3.3 Service Invocation

There are five components of WSMX involved in Service Invocation Process: Adapter, Communication Manager (Requester), Compiler, Communication Manager (Provider), Choreography Engine. Process of Service Registration explained by Robert Zaremba (2007) is as follows:

Service Requester specifies the Web Service and gives the Ontology instance. It is ensured by the Adapter that request is in WSML format. The Communication Manager of the Requester sends the Web Service and Ontology instance to the Compiler and Choreography Engine. Compiler checks the syntax of the document and Choreography Engine handles the Communication between both the Communication Managers using Mediator if necessary. Required Data is converted to XML format by Providers Communication Manager using

Data Mediator when necessary. Then Service Provider provides the service to the Service Requester, returning the data if required.

4.3 Realization of Conceptual Architecture

We are taking the process of Driving License Registration as an instance of the General Architecture of E-Government. Before mapping the process of Driving License Registration to the above Generic Architecture, we explain the manual process of Registration conducted in Pakistan.

4.3.1 Driving License Registration Process

This whole process is conducted manually in Pakistan except some work that is now automated.

First of all citizen is required to pay some amount in post office and then go to License issuing Office to get Learner's permit by taking NADRA ID photocopies and receipt of payment with him. This learner's Permit Application process is now computerized. All the information given in the Learner's Permit Application by the citizen is saved on computer and then this computerized permit is issued. Then after taking this Learner's permit, citizen is required to complete the file by attaching three passport size photographs, a copy of NADRA ID card, Learner's permit and Medical certificate.

Then after the process of completing the file, citizen is required to attach additional receipt of payment in file and submit that file in Licensing issuing office to apply for giving Behind-The-Wheel Test (Driving Test). Before giving the driving test, Traffic Police officer calls for traffic sign test. Officer asks 4-5 questions from the board having various traffic signs. Now in Pakistan this process is also computerized at some places. Touch screens are used for taking this test. After passing this test then behind-the-wheel test is taken by Instructor of Traffic Police.

After passing Driving Test, citizen submit his file along with additional fees receipt. Then Driving License is issued.

This is the whole process for which citizen is required to visit the Government offices. Now this process is automated to some extent. National portal of Pakistan (www.pakistan.gov.pk) contains some online forms (Learner's Permit, Medical Certificate, Driving Test Application form). But still citizens are required to take these forms and submit them manually by visiting the offices.

Following is the AS-IS Model of the Driving License Registration Process in Pakistan

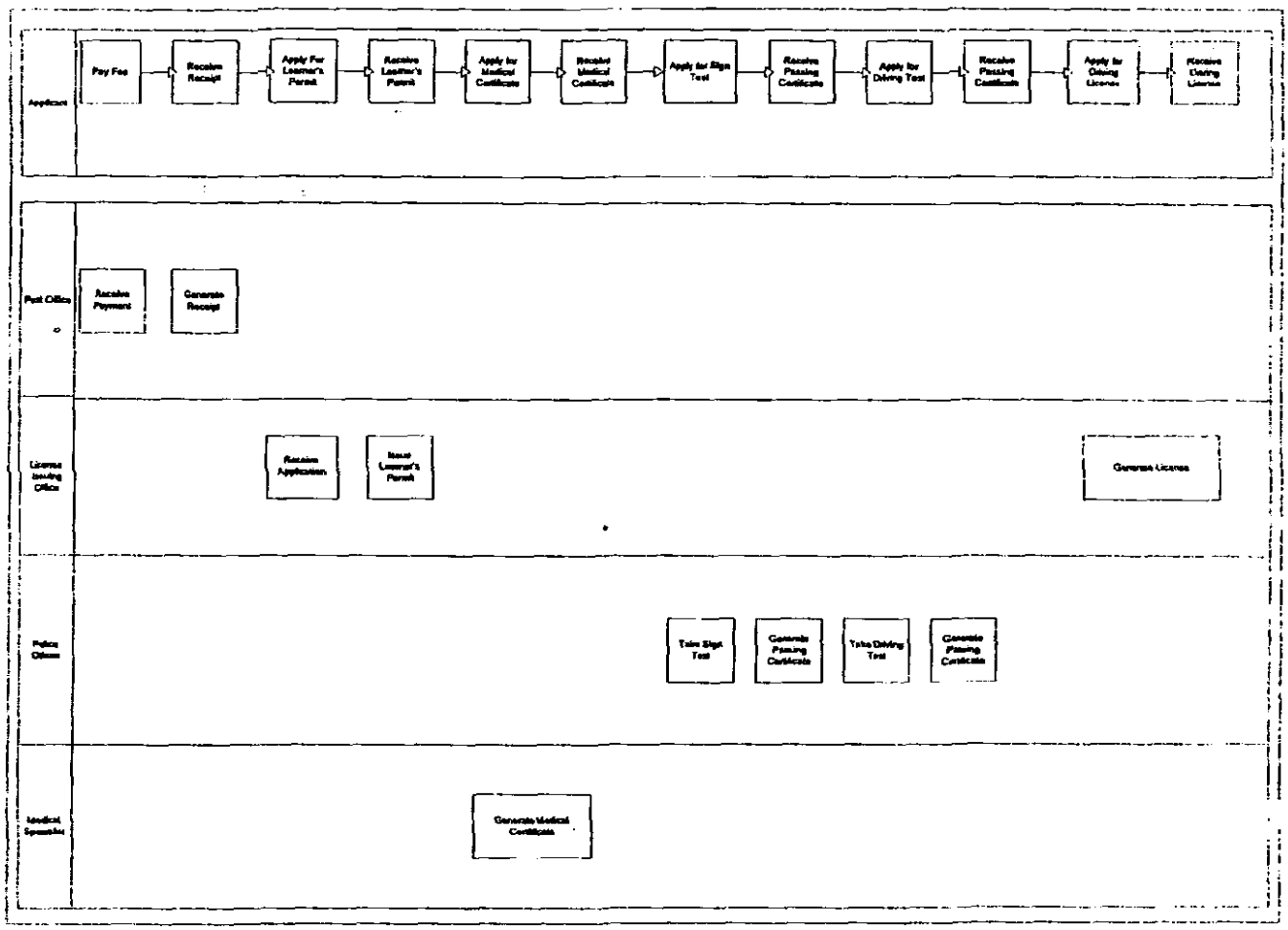


Figure 4.3 AS-IS Model of Driving License Registration Process

4.3.2 Mapping of Driving License Registration Process to Conceptual Architecture

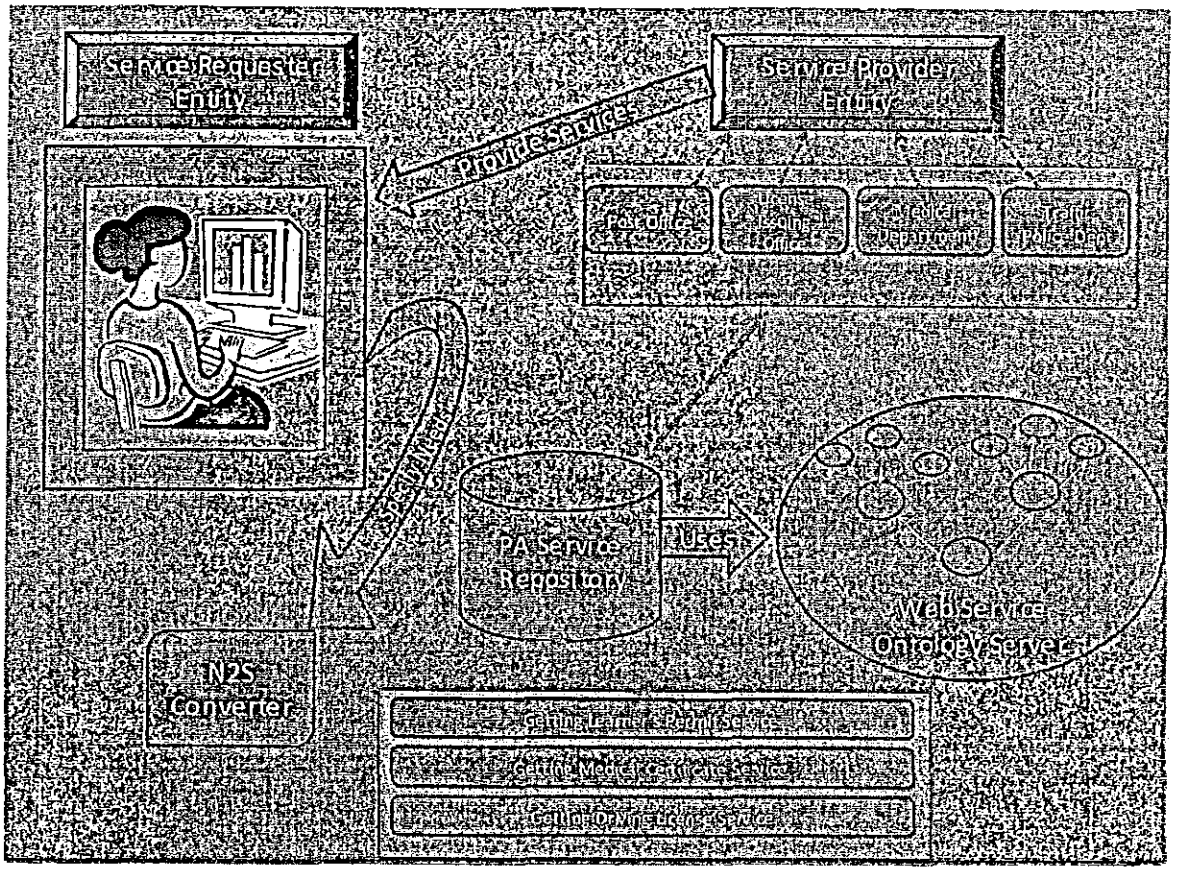


Figure 4.4 Driving License Registration Process

Main Service Providers involved in Driving License Registration Process in Pakistan are chosen from the above Conceptual Architecture of E-Government. Then required Services are taken for this Process from National PA Service Directory.

4.3.2.1 Service Providers:

There are four main Service Providers involved for issuing Driving License in Pakistan.

- **Traffic Police Licensing Issuing Office:**
  - This Office provides the Learner's Permit to the citizen. Process of getting this permit is not complex. Citizen is only required to go with NADRA ID Card and Driving License stamps and then Permit is issued to that citizen.

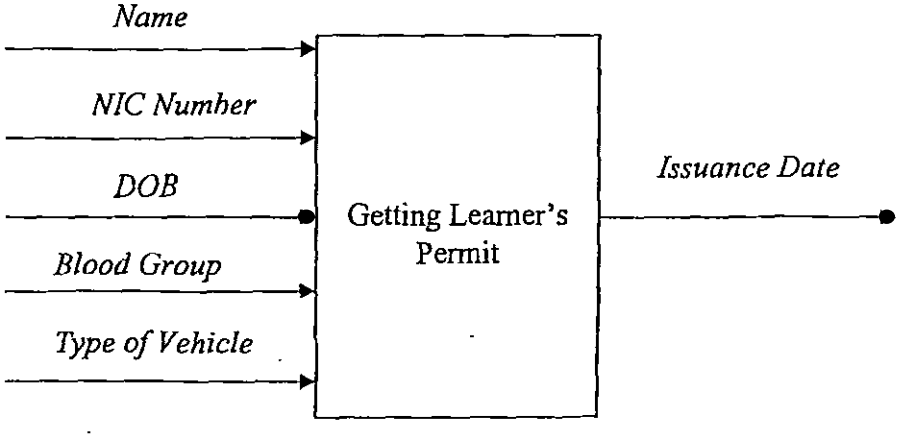
- **Post Office:**
  - Citizens can get Driving License Stamps from Post Office to submit in Traffic Police Licensing Office.
- **Medical Department:**
  - Citizens are required to take their Medical Fitness Certificate from Medical Department.
- **Traffic Police Dept:**
  - Citizens are required to give the Sign test to the Traffic police Officer. Once the citizen pass the Sign Test then driving Test (Behind the Wheel Test) is taken.

4.3.2.2 PA Service Directory:

This directory contains the main services chosen from the National PA Service Directory. Following are the services provided by the four above mentioned PAs.

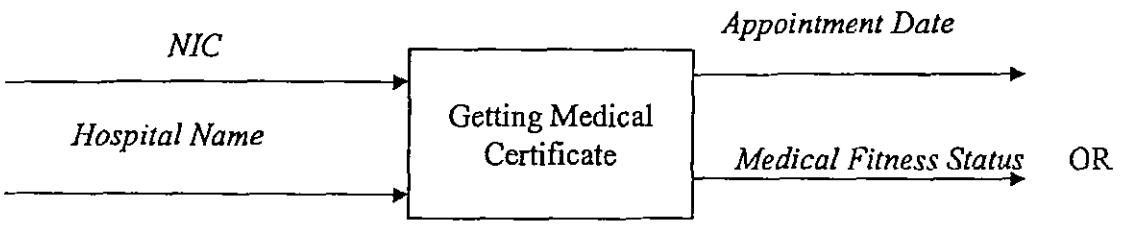
1. **Getting Learner's Permit**

Web service should be invoked which should take Name of the Applicant, NADRA Identity Card number, Date of Birth (DOB), Blood Group and Type of Vehicle as an input and should return the computerized Learner's Permit. Learner's Permit contains all the provided data along with issuance date.



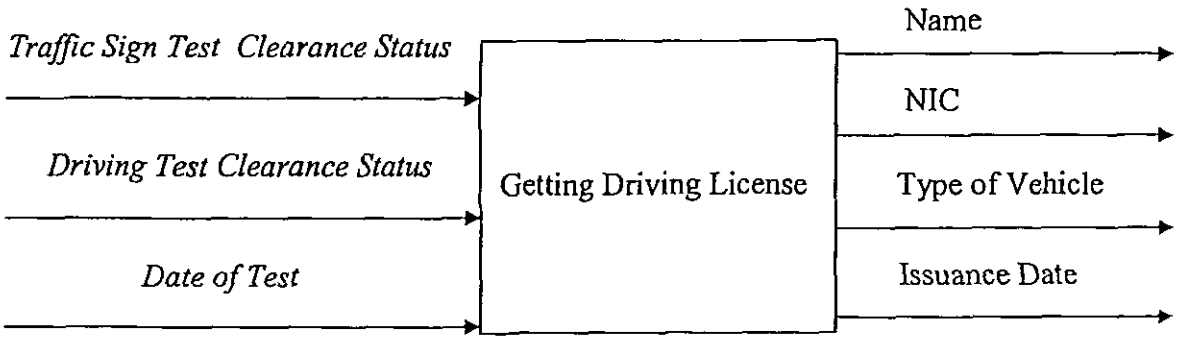
2. Getting Medical Certificate

It is assumed in our thesis that citizens are registered to any authenticated hospital and all these hospitals should also contain this application running on their systems. When the user wants to have medical certificate, he should give name of the hospital and NIC Number as an input to this web service, Web service is required to contact the Web Service running in that hospital. In return that Web Service will either give user's fitness certificate or will give appointment date and time.



3. Getting Driving License

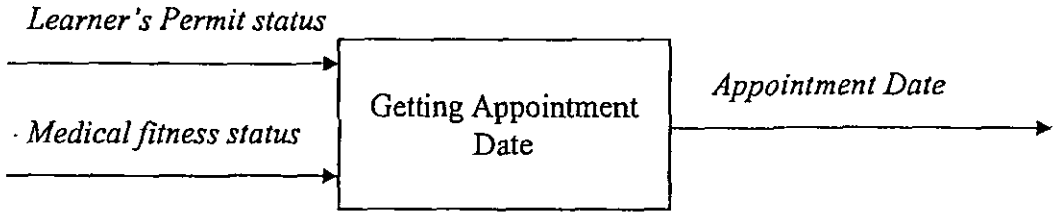
This process cannot be automated fully, user has to visit the Issuance Office for giving Driving Test. Traffic Police Officer takes the Driving Test but before that Traffic sign Test must be cleared. Issuance Office is required to take Traffic Sign Test first and if status of that Test is "PASS" then Driving Test is taken by the Issuance Office. Traffic Sign Test Clearance status and the Driving Test Clearance status is given as an input to the Web Service and Driving License is generated as an output. Driving License contains the Name of the Applicant, NIC Number, Type of Vehicle and Issuance Date



For executing this above described Web Service, following Web Service is required to be successfully executed first.

a. Getting Appointment Date for Traffic Sign Test and Driving Test

This web Service should take Learner's Permit status and Medical fitness status as an input and should give appointment Date for Traffic Sign Test and Driving Test as an output.



As the execution of one Web Service is dependent on other therefore the basic flow of executing "Getting Driving License Web Service" is shown in the figure 4.5

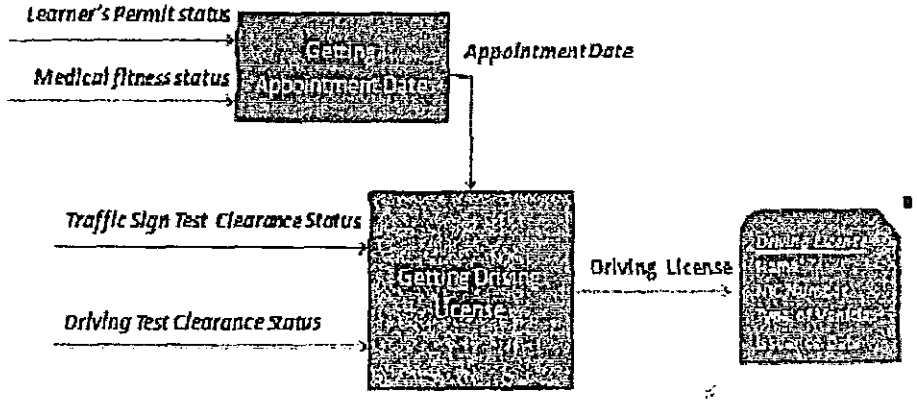


Figure 4.5 Flow Diagram

4.4 Flow of Automated Driving License Registration Process

Figure 4.6 shows the full process of Automated Driving License Registration Process. User applies for Learner's Permit giving the information including Full Name, Father Name, NIC Number, Blood Group, Date of Birth, Permanent Address. In response Web Service returns the Computerized Form which is called as Learner's Permit containing all the provided information along with Issuance Date.

For getting Medical Certificate second Web Service takes the NIC Number of the applicant and name of the hospital where he/she is registered. It is assumed that all the applicants are registered in some authenticated hospital.

Finally the Medical Fitness Certificate, Learner's Permit, Traffic Sign Clearance Form and Driving Test Clearance Form is provided as an input to the web service of getting Driving License . Driving License is generated as an output to the citizen.

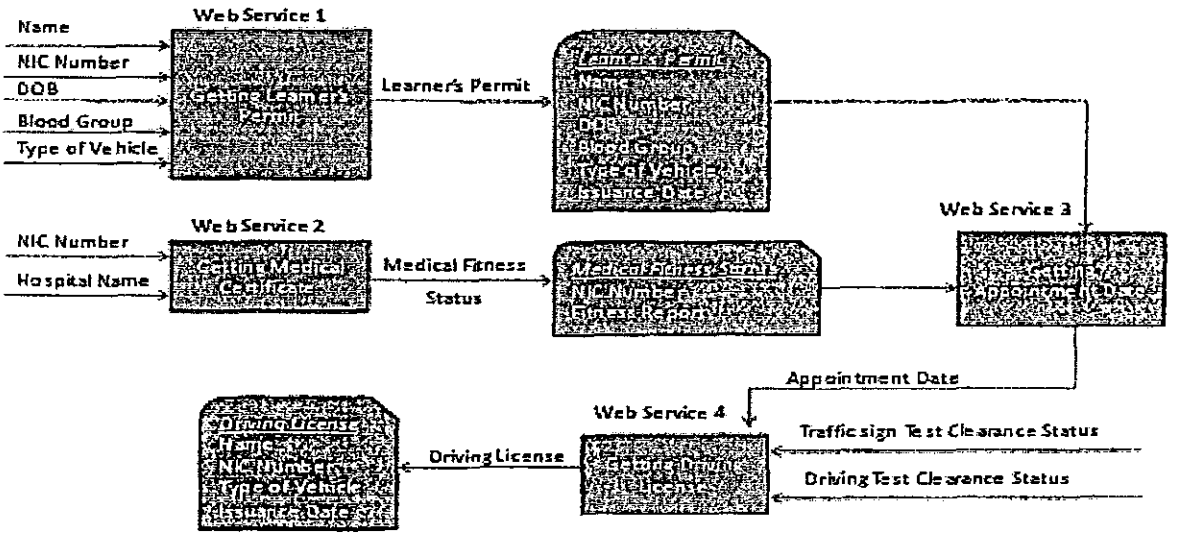


Figure 4.6 Flow Diagram of Driving License Registration Process

Chapter 5

Implementation

5 Implementation

We have implemented Driving License Process in WSMT which is a test bed for WSMO using WSML as a Language. First of all WSMT is explained then implementation of Driving License process is described.

5.1 WSMT

It is called as Web Service Modeling Toolkit. It is a framework where all the tools related to Semantic Web Services are deployed. It is basically a unique central platform where users can manage all the Semantic Web Services implemented in Eclipse Framework. According to Mick Kerrigan et al (2007) WSMT focuses on three main functionalities: Engineering of WSMO descriptions (making ontologies), creation of mediation mapping, interfacing with execution environment. Therefore for fulfilling these functionalities, WSMT is divided into three perspectives: WSML, Mapping, SEE Perspective.

5.1.1 WSML Perspective

WSML Perspective provides a lot of tools that supports to create, manage and interact with ontologies (semantic descriptions) through WSMO paradigm. These tools are listed below:

- WSML Validation
- WSML Text Editor
- WSML Form Based Editor
- WSML Visualizer
- WSML Reasoner View
- Discovery View

5.1.2 Mapping Perspective

For correct Data Exchange between two entities, mapping is necessary as it is not possible that both the entities uses the same ontology to represent the data. Automatic mapping do exists is WXMT but their accuracy level is low.

5.1.3 SEE Perspective

Basic purpose for Semantic Web Services is to enable the automatic discovery, composition, selection and mediation and also to enable the conversation between requester and provider with minimum human intervention. To perform these tasks interfacing with the SEE is required.

5.2 Implementation of Driving License Registration Process

Driving License process explained in previous chapter is implemented in WSMT. First of all General Ontology is made which is common for both requesters and providers. For simplicity same ontology is used for Goal and Web Services in our implementation. We have worked in WSMX (Web Service Execution Environment) which is a front end tool of WSMT.

Before giving the implementation details about Ontology, Web Services and Goals, we are explaining the access points of WSMX and the Discovery process of WSMX.

5.2.1 WSMX Entry Points

There are four Entry Points in WSMX

- achieveGoal
- discoverWebServices
- invokeWebServices
- store

We have created Web Services and Goals and then used discoverWebServices entry point which returns the matched services as an output.

5.2.2 Web Service Discovery

- Keyword-based Discovery
    - This type of discovery considers only non-functional properties

- Lightweight (functional)
  - This type of discovery considers only the postconditions specified in Capability. It uses WSML-Flight Variant.
- Lightweight Rule
  - This type of discovery considers only the postconditions specified in Capability. It uses WSML-Flight/Rule Variant. It will replace the previous Lightweight Discovery.
- Lightweight DL
  - List of Discovered Web Services is given according to type of Match and degree of Match like exact, subsumes, plug-in, intersect. It uses WSML-DL Variant.
- Rule (Heavyweight)
  - Considers both Preconditions and Post conditions. It uses WSML-Rule Variant.

We have selected Lightweight DL discovery. Therefore we have to specify only the postconditions in Web Services as well as in Goals.

5.2.3 Driving License Ontology

There are seven main concepts in our ontology.

- **Profile:**
  - This concept has four attributes: Name of Type (String), NIC Number of Type (String), Age of Type (Integer), Blood Group of Type (String).
- **Category:** Four instances are taken as an example in this research. Two attributes are taken for each instance i.e, Name and Weight of type (string).
  - Category A
    - Name hasValue CatA
    - Weight hasValue Above50kg

- Category B
  - Name hasValue CatB
  - Weight hasValue Above100kg
- Category C
  - Name hasValue CatC
  - Weight hasValue Above150kg
- Category D
  - Name hasValue CatD
  - Weight hasValue Above200kg

➢ **Learner's Permit**

- This concept has three attributes i.e, issuingDate of type (Date), Category of type (Category Concept), isIssued of Type (Bool)

➢ **Medical Certificate**

- This concept has six attributes: PName of type (Profile Concept), NIC of type (Profile Concept), FittnessCertificateStatus of type (bool), AppointmentDate of type (date), isRegistered of type (bool), isIssued of type (String).

➢ **Traffic Sign Test**

- This concept has two attributes: PASS of type (bool), Appointment Date of type (Date).

➢ **Driving Test**

- This concept has two attributes: PASS of type (bool), Appointment Date of type (Date).

➢ **Driving License**

- This concept has six attributes: issuingDate of type (Date), expiryDate of type (date), signTest of type (Traffic Sign Test Concept), drivingTest of type (Driving Test Concept), Category of type (Category Concept), isIssued of type (String).

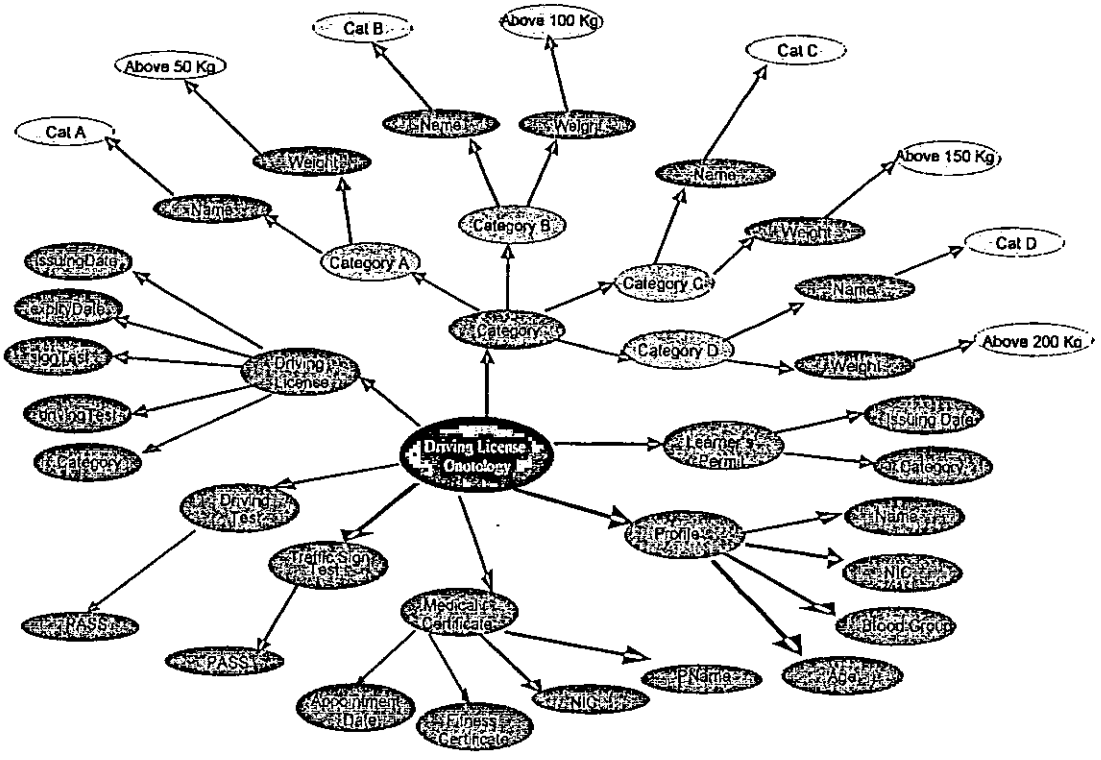
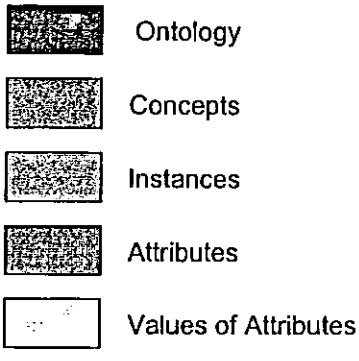


Figure 5.1 Driving License Ontology



5.2.4 Web Services

We have developed web services in WSML. As described above we have chosen Lightweight DL Discovery. There are mainly four Web Services.

5.2.4.1 Getting Learner's Permit

For Learner's Permit issuance age must be greater than 18 years. Therefore Age is the precondition and postcondition is that Learner's Permit is issued.

5.2.4.2 Getting Medical Certificate

For Getting Medical Certificate it is assumed in our thesis that citizen is registered in any authenticated hospital. Therefore precondition is that citizen is registered and postcondition is that Medical Fitness Certificate is issued.

5.2.4.3 Getting Appointment Date for Traffic Sign Test and Driving Test

Preconditions are that citizen got Learner's Permit and Medical Fitness Certificate and post condition is that they get appointment date.

5.2.4.4 Getting Driving License

Preconditions are that citizen has passed Traffic Sign Test and Driving Test. Postcondition is that Driving License is issued.

5.2.5 Goals

We have developed Goals in WSML. As described above we have chosen Lightweight DL Discovery. Same preconditions and postconditions are specified in Goals as that of Web Services. There are mainly four Goals.

5.2.4.1 Getting Learner's Permit Goal

To acquire our Goal of getting Learner's Permit precondition is that age must be greater than 18 years and postcondition is that Learner's Permit is issued.

5.2.4.2 Getting Medical Certificate Goal

As it is assumed in our thesis that citizen is registered in any authenticated hospital. Therefore to acquire this Goal precondition is that citizen is registered and postcondition is that Medical Fitness Certificate is issued.

5.2.4.3 Getting Appointment Date for Traffic Sign Test and Driving Test Goal

For getting Appointment Date Preconditions are that citizen has Learner's Permit and Medical Fitness Certificate and post condition is that he gets appointment date.

5.2.4.5 Getting Driving License

For acquiring Driving License Preconditions are that citizen has passed Traffic Sign Test and Driving Test. Postcondition is that Driving License is issued.

Chapter 6

Conclusion

6 Conclusion

6.1 Introduction

In our thesis we have addressed the problem of supplying the correct information to the citizens of Pakistan from public administration in quick and easy way. Main aim is to facilitate the citizens with their required services in less time and cost. Therefore we have focused on E-Government Domain which aims at providing the citizens with their required services in an easy and efficient way. For that we have studied different Web Technologies and also highlighted their advantages and limitations. After studying all the web technologies, we have selected Semantic Web Service Technology to address the problem of getting correct information dynamically.

To address this problem, we have proposed a Framework for E-Government in Pakistan. This framework is based on Service Oriented Architecture using Semantic Web Technology. For having realization of this Framework, we took the domain of Driving License Registration as a test case. Domain knowledge of this registration process is shown by an ontology. We have created this ontology in WSML (Web Service Modeling Language) showing the main concepts and their attributes. Then we have created the Web Services and Goals in WSML to show the discovery process.

6.2 Achievements

Over the last few years due to advancement in information and communication technologies, interaction of citizens with Government processes is also increased. Citizens are getting more aware of their demands for getting information from the Government. Therefore E-Government domain is the main interest now a days. Around the whole world Governments are fully responding to the information age so is the case with Pakistan. Pakistan is also trying to provide its citizens with their required services in an easy and efficient way but still lags behind in this field.

We have also presented a framework for E-Government of Pakistan to improve the service delivery to the citizens and to increase the internal efficieny of the Government processes. Our main focus is to improve the quality of the services provided to the citizens therefore our

proposed framework is based on Service Oriented Architecture using Semantic Web Services Technology. This is an emerging technology and Europe is gaining full advantage of it by using it in their Government sector. But still Pakistan lags behind in this field. Uptil now no work has been done in the direction of Semantic Web Service Technology in E-Goernment sector.

Thus our research work is an initial step towards using Semantic Web Service Technology in E-Government of Pakistan. It will help in increasing the accuracy and efficiency of the Government processes. It is the initial step towards the creation of single unique platform from where citizens can get their required services easily.

6.3 Improvements

There are lot of improvements required in E-Government Sector of Pakistan. Pakistan has now a National Portal from where Citizens can get their required information but still this Portal contain the static information for most of the processes. Only static forms are available for downloading but no transactions are there, manual work is required.

No work in Semantic Web Services field is done so far in E-Government sector. Pakistan is in need of detailed research work in this area so that E-Government sector can be fully automated and citizens can have full advantage of it.

6.4 Future Recommendations

We have taken an initial step to introduce E-Government Framework for Pakistan that is based on Semantic Web Service Technology. But there is a need of much improvement in this sector in future. First of all detailed requirement analysis is required to further modify the Framework. This framework should be flexible enough to consider the citizens ease, should allow much participation of citizens to achieve their goal of utilizing their required services. Proper policies should be made to fulfill the citizen's expectations and these policies should be transparent.

We have tested one of the processes of the Government that is Driving License Registration Process as an examplery case. In future detailed study is required to make a proper strategy

about how this Framework can be successfuly implemented in Pakistan and then other Government processes should also be tested upon this framework.

6.5 Summary

We have proposed a conceptual Semantic Web based architecture for E-Government of Pakistan. Before that no work has been done in this field therefore it is an initial step. As our research is in early stages so much work is required to properly analyse the requirements for the successful implementation of this Framework in Pakistan.

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