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A Novel Approach for Implementing Virtual Medical Analysis using Semantic Web Services

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ABSTRACT--- ***The out patients visit a multitude of laboratories in order to check the availability, price, and result durations from the nearest laboratories which are related in the web sites, in medical analysis laboratory. This results in the reducibility or limitations of usability of such web sites. To overcome this problem we propose this paper, Virtual Medical Analysis Laboratory prototype system which will be based on applying the Semantic Web Services which will enable the outpatient test to discover suitable laboratory. We propose this VMALP based on web service modeling ontology.***

Keywords---- Virtual Medical Analysis Laboratory Prototype [VMALP], Semantic Web Services [SWS], Web Services Modeling Ontology[WSMO], Web Services Description Language[WSDL], Web Services eXecution Environment[WSMX]

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1. INTRODUCTION

Software Components accessible through the web is referred to as the web services. Web Services Description Language and their related other descriptive language may not provide sufficient semantics which are processed by machine [1].More over it requires interpretations of meanings for the technical terms and to discover the web services manually, consumes more time and error prone [2]. The semantic web researchers provide to augment the Web services with a semantic description of functionality in order to facilitate their integration and discovery [3]. This approach is combination of web services with semantic web technology. The SWS also possess the property of modifying the knowledge and business services provided on the web [4].

SWS provides an appropriate service for users requirement in the discovery of web .In order to complete specific task especially in business environment this is the first step towards service selection and composition. Therefore, this paper is proposed for discovering the suitable SWS in addition to its existing approaches.

This paper also proposes a VMALP system using SWS in order to scheduling outpatient test such as blood test, thyroid test, ECG, MRI scan etc,. This prototype could be used to discover the suitable laboratory. Every Web Service is being implemented with wide different technologies which makes them more flexible.

The paper is organized as follows: Section 2 - summarizes the main approaches related to SWSs technology. Section 3 -introduces the proposed prototype in details. Section 4- describes the new features to be added. Finally, Section 5- concludes the paper and outlines the future work.

2. SEMANTIC WEB SERVICES APPROACHES

Web service technologies bring a dynamic aspect to overall Web usage. However the current understanding about web services fails to capture enough semantic data. Therefore, semantic services deal with such limitation by augmenting the service description with a semantic layer in order to achieve automated discovery, composition, monitoring, and execution, which are all highly desirable processes [5].

However, several approaches have already been suggested for adding semantic to Web services. Semantics can either be added to currently existing syntactic Web service standards such as Universal Description, Discovery and Integration (UDDI) [6] and Web Services Description Language (WSDL), or services can be described using some ontology based description language. The Major initiatives in the area of SWSs are documented by W3C member submissions, such as, OWL-S [7], WSMO [8] and WSDL-S [9].Ontology Web Language for Services (OWL-S) is a description language that semantically describes Web Services using OWL ontologies. OWL-S services are mapped to WSDL operations, and inputs and outputs of OWL-S are mapped to WSDL messages.

The Web Services Description Language - Semantic (WSDL-S) is an evolutionary and backwards compatible extension of the existing Web Services standards and descriptions language, which augments the expressivity of WSDL with semantics in an arbitrary semantic representation language.In addition, it provides a means to supply semantic information, but actual semantic functionality has to be provided by additional components, which are not part of the WSDL-S initiative.

The WSDL-S proposal was replaced by Semantic Annotations for WSDL (SAWSDL) [10], a W3C recommendation, which is a simple and generic mechanism for semantically annotating Web Service descriptions. The SAWSDL is a restricted and homogenized version of WSDL-S in which annotations like preconditions and effects have not been explicitly contemplated. The Web Services Modeling Ontology (WSMO) provides ontological specifications for the description of SWSs [11]. One of the main objectives of WSMO is to give a solution to application integration problems for Web Services by providing a conceptual framework and a formal language for semantically describing all relevant aspects of Web Services [12], Table 1 depicts the main differences between the three approaches.

	OWL-S	WSMO	WSDL-S
Scope	Description model for semantically describing Web Services	Description model & language for core elements of Semantic Web Service technologies	Semantic Annotation of WSDL description
Top Level Elements	Service Profile Process model Grounding	Ontologies Goals Web Services Mediators	Operations/ WSDL descriptions
Language	OWL	WSML	Not specified
Maturity of the approach	Strong	Medium	Medium
Mediation	Under development	Strong (MEDIATORS elements)	Not specified

TABLE:1- COMPARISON BETWEEN THE THREE APPROACHES

WSMO is the only initiative which has an explicit notion of mediation [13]. Furthermore, WSMO is the only standard for which there exist several implementation environments which aim to support the complete standard [14]. For these reasons WSMO is used as our SWSs technology throughout the rest of this paper. In addition, WSMO model consists of both the requester and provider sides, and thus, it gives the opportunity to the requester (user) to define a goal in order to find a semantically annotated web service. Ait-Ameur [15] proposes a semantic repository for adaptive services in which he uses a semantic registry, to store SWSs. However, this, semantic registry is equipped with an exploitation language that supports semantic based process discovery. Moreover, Belaidetal [16]. Apply ontology and indexation based management of services and workflows to the Geological Modeling.

3. PROPOSED PROTOTYPE

3.1. MOTIVATION:

It is obvious that finding out the required web sites or services is difficult and Prone to error which may also be time consuming when without using automated mechanism. This issue is similar to search in web pages without using browsers. Service consumer can be user, another service or a program. Thus, the idea of using automated mechanism is for finding the appropriate services or websites [17].SWSs technology can be used to optimize several processes in the domain of e- health especially in Medical analysis[18].These processes are mainly related to human attractions, and consequently to associate with them. Hence, the main benefits of applying SWS technology are that it could permit to develop and maintain e-health services with lower costs. The main aim of SWS is to search in available registries rather than searching elsewhere and optimizing manual search so that the new web services can be deployed and can be discovered easily and quickly. Figure 1 below, presents two scenarios that motivated us to develop this prototype. In the first scenario, for an outpatient test (blood test, urine test, etc.), the patient often must visit the web sites for many different laboratories in order to check the availability, prices, result duration and also to find the nearest laboratory

Using phone directories is also needed if some web sites laboratories are not available. The patient should contact each laboratory by phone or email to get the necessary information, such as address, distance from home, price, possible results, etc. This method is very difficult and time consuming, especially when the patient needs to visit many laboratories.

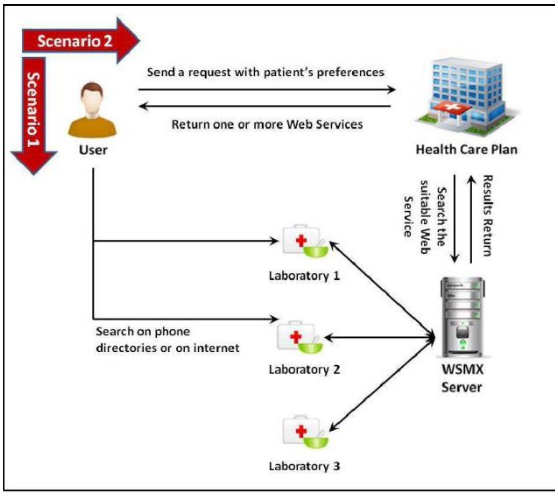

FIGURE 1. THE MOTIVATION SCENARIO

In the second scenario, to overcome the disadvantages in the first scenario, the Virtual Medical Analysis Laboratory (VMAL) prototype system is proposed to discover the suitable Laboratory by applying SWSs for scheduling outpatient tests (blood tests, urine tests, etc.).In order to model the scenario, we propose prototype which is based on Web service Modeling Ontology(WSMO).We use WSMO for modeling of services and goals(i.e. required and offered capabilities) as well as Ontology (i.e. structural frameworks for organizing information and are used in ARTIFICIAL INTELLIGENCE) all written in the WSML ontology language.

The scheduling of the required tests could be done through the following steps:

- Required tests are informed by the patient who she/he wants to do (blood test, urine test, etc.)
- The system searches and discovers what laboratories can do these tests (discover web services from laboratories) and
- The system returns a list of one or more discovered Web Services to the patient.

A request has been sent by the patient to the portal with her/his preferences of choices. In the WSMX server, a suitable searching process for Web Services is carried out where all the Web Services are stored. Finally, the patient receives one or more Web Services according to her/his request. Next Subsections will explain the main architecture of the prototype more clearly.

3.2. THE WSMO FRAMEWORK

This document presents an ontology called Web Service Modeling Ontology (WSMO) for describing various aspects related to Semantic Web Service. WSMO (Web service Modeling Ontology) is a formal ontology and language which identifies the following four main top- elements:

- Ontology that provide the terminology used by other elements;
- Goals that state the intentions which should be solved by Web Services;
- Web Services descriptions which describe various aspects of a service;
- Mediators to resolve interoperability problems.

The Web service modeling ontology (WSMO) provides a conceptual framework for describing Web services semantically and their specific properties. The WSML (Web Service Modeling Language) is a formalization of the WSMO ontology and providing a language within which the properties of SWSs can be described.

Each of these WSMO Top Level Elements can be described with non-functional properties, such as, creator, creation date, format, language, owner, rights, source, type, etc. Furthermore, WSMO comes along with a modeling language (WSML) and a reference implementation (WSMX).WSMX (Web Service Modeling eXecution environment) is the reference implementation of WSMO (Web Service Modeling Ontology). It is an execution environment for business application integration where enhanced web services are integrated for various business applications. The aim is to increase business processes automation in a very flexible manner while providing scalable integration solutions. Whereas, the WSMX (Web Service execution Environment) provides an architecture including discovery, mediation, selection, and invocation. In addition, it has been designed to include all the required supporting components enabling an exchange of messages between requesters and the providers of services.

3.3. ARCHITECTURE OF THE PROTOTYPE

The VMAL prototype could be used to help users of the medical laboratories to schedule their outpatient tests (blood tests, urine tests, etc.) Figure 2 presents the architecture of the prototype. The patient communicates with the VLMA portal via the HTTPS protocol,which provides a secure communication channel.

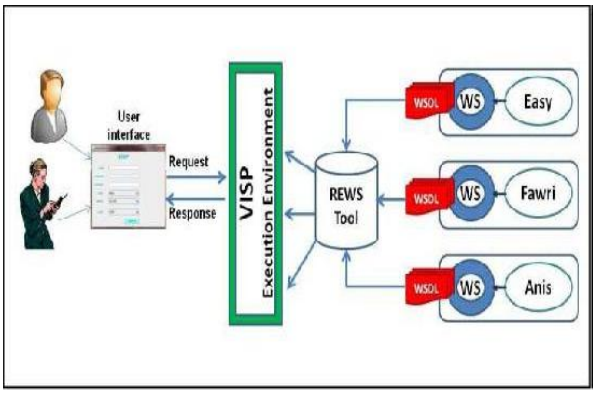

FIGURE 2. THE ARCHITECTURE OF THE PROTOTYPE

The essential functionalities of the proposed prototype process applied to medical analysis are as follows:

- Provide a friendly interface for patient interaction.
- Discover suitable Web Services according to patient preference (availability, distance, price, etc.).

Much of the promise of Web Services is its potential for seamless interoperability across heterogeneous systems, platforms, applications, and programming languages. The primary goal of web services is Interoperability. Web services standards facilitate interoperability, but do not ensure it. The proposed prototype consists of three Web Services WSMX servers and a simple interface client application implemented with Java language that communicates with the WSMX Server. The implementation of the three Web Services is with different platforms and programming languages. This makes our prototype more flexible because we consider the WSDL file as our only source of information and the choice of these programming languages is random. Web Service was formerly implemented with the Java language and the Net Beans Platform, the second with the .NET and the third one was implemented with PHP and MYSQL. The services were published by the service providers and made a description of it in Web Service Description Language (WSDL).WSDL provides the way through which Web Services can be described according to their functional, non-functional behavior. All the WSDL files are submitted to the Reverse Engineering Web Service Application (REWS) tool [19] for extracting the main WSMO Web Service elements, which are written in WSML language and then will be stored in the WSMX Server.

In our prototype, the role of UDDI directory, in which all Web Services are stored, is played by the WSMX server. All semantic descriptions are provided on top of existing providers' syntactic services virtually, making providers unaware of this semantic layer. No changes are involved in services and native data formats are preserved. The WSMX server acts as transparent and intermediary layer, which is actually a computer where the WSMX is installed and configured, between interacting parties for mapping and discovery. It consists of some components that fulfill Web Services tasks such as discovery, invocation, composition, etc.

The requirements of the patients are expressed via web forms (see Figure 3) which are mapped to appropriate Goal and expressed in WSML language. Once a WSMO Goal with its actual values is created, then it can be sent to WSMX, where provider matching this Goal is discovered, and according to Goal and Web service choreography communication is carried out. At last, one or more Web Services are returned to the patient. This scenario is very simple, and the use of needed in this case. The reason for choosing this scenario is to keep the implementation within the scope of the project and because it uses the most important and basic parts of WSMX.To be able to fulfill this scenario, WSMO ontology elements must be created to provide a shared vocabulary for the different interactions.

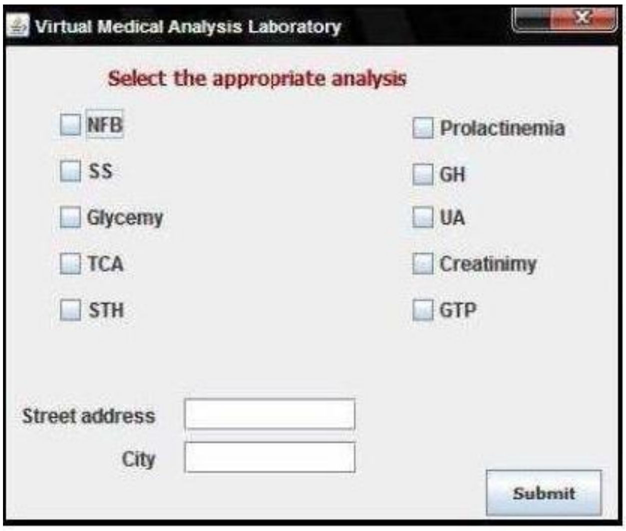

FIGURE 3. USER INTERFACE SNAPSHOT

3.4. SYSTEM PHASES

According to WSMO, to develop SWS, the actual Web Service should be implemented; a WSMO web service should be created to describe the web service. Also, the necessary ontology used by the Web Service should be defined. Then, to test it; a goal needs to be created, that is, to represent a request to WSMX and the ontologies used by it. The discovery process can be split into eight high- level steps.

The following describes, in more details, the different phases of the process.

PHASE 1: CREATING WSMO WEB SERVICES ELEMENTS

Providers' Web Services have to be semantically described to include lifting arbitrary XML messages in WSDL document to the semantic level by the ontology conceptualization.

In this phase, the REWS tool has been used to create WSMO Web Services elements. It takes as input WSDL File of each Web Service and generates as output the web Service Elements expressed in WSML language. Then, these elements will be stored on the WSMX server for further using. Figure 5, depicts part of a WSML file according to the first Web Service.

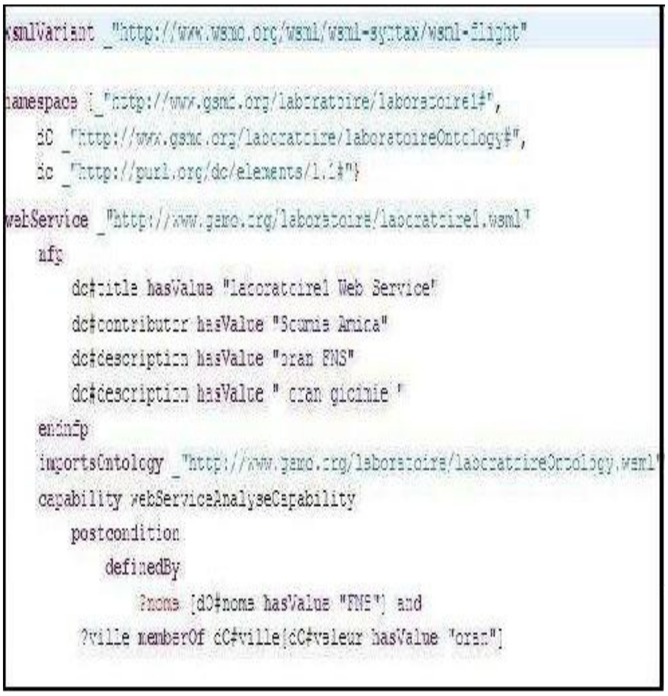

FIGURE 5.SNAPSHOT OF A PART OF WML WEB SERVICE FILE

PHASE 2: CREATING WSMO GOALS

Patient does not have to visit multiple web sites, but can use only the friendly interface provided by the portal (see Figure 3 above) that aggregates multiple Medical analysis services, and sure it can be extended with new ones. The requirements and behavior of the client have to be expressed as WSMO Goal.The patient has to introduce necessary data to find Medical analysis offers. The Service Discovery component refines the suggested Web Services resulted from the discovery and chooses the most appropriate web service based on the requester's preferences.

The system accept the expression of patients' goals using Web forms that in turn are mapped to WSMO Goals, and allow them to be executed by WSMX. In the proposed prototype, the Goals are based on a template approach where the Goal structure is defined but actual input values can be provided during the run-time by the patient.

PHASE 3: MATCHING WEB SERVICE TO GOAL

Now, the Goal is submitted to WSMX, whereas, the provider matching this Goal is discovered, and then according to the Goal itself and Web Service choreography communication is carried out [20].

The Discovery component of the WSMX server then starts to match the capabilities required by the goal, with the capabilities of the Web Services already registered in WSMX discovery component of the WSMX platform. The default matching criteria are the Keyword-based discovery and the Lightweight discovery. The former relies on matching the Non- Functional properties defined by the Web Service and the goal, while the latter compares the Post conditions and the Effects specified in the two interfaces. After that the Service Discovery component refines the suggested web services resulted from the discovery and chooses the most appropriate web service based on the requester's preferences. Some user preferences can be specified using Non-Functional properties. After the web service is chosen, a response is returned to the patient with suitable Web Services links.

WSMX takes a semi-automatic approach to this problem. Initially, three Web Services were loaded to WSMX. Then to perform the discovery, the WSMX server used both the Keyword-based and the Lightweight discoveries. Two Web Services were discovered, the first one using the Keyword discovery and the second one using the Lightweight (see figure 6 below). The human's role is to ensure accuracy of these mappings and to adjust them if necessary.

FIGURE 6. SNAPSHOT OF THE DISCOVERED WEB SERVICES

4. CONCLUSION

The SWSs can be used to transform the existing syntactic web into a dynamic and semantic one, in which this transformation allows automating the use of web services. Hence these SWSs are considered to be very powerful paradigm.

Especially, the discovery of SWSs has become an important when large number services are available for use on the Internet, so the acquisition of appropriate SWS is the main goal for a user who is searching for a service. This paper describes a prototype of a Virtual Medical Analysis Laboratory (VMAL) application for demonstrating how the application of SWSs technology makes it possible for individual patients to find the suitable laboratory for scheduling outpatient tests.

As a future work, this proposed prototype could be extended to transport Web Services. In addition, such prototype could also be used with many applications in Web Services. Also we propose some new features to be included, which can optimize the semantic searching of web services.We provide the patients, with an added choice of getting medical advices from the specialized practitioners and doctors related to various medical fields ,by providing information's of them such as e-mail address, clinic address etc,. So that the patients can make a direct consultation with them, which helps the outpatients to be benefitted more at much lower costs with great ease.

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