A Novel Semantic Web Service based Approach for making the Immunization Programme more Effective in Rural Tamil Nadu

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ABSTRACT
Semantic Web plays a vital role in healthcare domain. Immunization is one among the effective methods of preventing childhood diseases. The objective of the current work is to evaluate the immunization coverage of children in a specific rural area in the state of Tamil Nadu, India and to strengthen immunization services based on the study findings. It is expected that this can be achieved through the development of a semantic web services framework that would be deployed to provide healthcare delivery services effectively for rural Indian communities.

General Terms
Semantic Web, Web Services

Key Words
Healthcare, ontology, semantic web, vaccination, web services

1. INTRODUCTION
India ranks low globally in its rate of vaccinating its population. An accepted indicator of a successful vaccination program is the percentage of babies receiving the three doses of the DPT vaccine against diphtheria, tetanus and whooping cough. In 2010, India recorded only 72% according to a joint estimate United Nations Children's Fund and the WHO that compares poorly with Bangladesh at 95% and Indonesia at 83%, according to the same joint estimate [1].

Immunization against common childhood diseases has been an integral component of mother and child health services in India since adoption of the primary health care approach in 1978 being reinforced by the Declaration of Health Policy in 1983 [2]. The focus of this paper is to examine the status and performance of the child immunization programme in a specific rural area of Kanyakumari District, Tamil Nadu, India and to suggest policy and programmes for realization of the goals of universal immunization services.

This paper presents our research in the design and implementation of a framework for cost cutting electronic healthcare delivery services for rural/suburban communities. This can be achieved through the development of a semantic web services framework that would be deployed to provide healthcare delivery services effectively for rural Indian communities. Currently no e-health application making use of semantic web services are known or reported in literature to have been implemented in any real life situation in India.

2. SURVEY
Tamil Nadu Government is providing Web-based software, Health Management Information System [3] which is accessible from all PHCs which are provided with Internet access. All the health functionaries are trained to use this software and enter the data collected by them during their field work at the PHCs. They are given intensive training programme for 3 days.

In order to better understand the status of the primary healthcare in the rural areas of Tamil Nadu, its quality, infrastructure, manpower availability, we conducted a survey of Primary Health Centre in Chenbagaramanputhoor (C.R. Puthoor), K.K. District, Tamil Nadu.

The C.R. Puthoor Primary Health Care (PHC) centre has one computer with Internet Access and all the health functionaries are provided with a mobile phone. One important activity performed by Health workers is to collect data about the AN mothers every Monday during field work, which is recorded in paper initially. On their return to the PHC, the health care workers have to feed this data manually into the master database using the Health Management Information System software. At this stage, each AN mother will be assigned with an unique ID. Now they are officially registered at the corresponding PHC and can be tracked for further observation and follow-up actions. The mothers can also use this ID to gather any required information in future. Only registered persons can get information from the Web-based software

3. RECOMMENDATIONS
During the initial survey we observed that the Health Management Information System provided by the Tamil Nadu Government is effective in the implementation of immunization programme. Due to this there is a drastic reduction in the incidence of vaccine preventable diseases. Observations from the present study has helped us to identify some areas where improvement is possible which may help to achieve 100% immunization coverage in a cost-effective and efficient manner.

As society progresses into a new era of Web-based health information, integrating semantics into the health system has been proposed as a key component of any future clinical infrastructure [4].

Healthcare systems need to manipulate semantically rich and highly structured clinical data. This can be achieved with the help of ontology and semantic web services. Ontology [5] represents knowledge about a particular domain, in our case, the medical domain. This knowledge includes entities in the domain, their property and relationship with each other. Web Ontology Language (OWL) [6] is one among the ontology-based language that can be used for representing such clinical data on the Web.

The formation of Semantic Web Services (SWS) [7] makes it possible to discover, implement and compose Web service automatically. OWL-S [8], the description language of Semantic Web Service, increases flexibility of Web service description, enriches expressiveness of it and provides a capability-based mechanism of Web service discovery.

4. DESIGN & IMPLEMENTATION

As a step towards the realization of the proposed work, the following activities (steps) have been carried out:

1. Development of domain knowledge using Protégé
2. Development of web services using Eclipse
3. Creation of OWL-S services for the developed services using OWL-S plug-in of Eclipse

Step 1:

Domain Ontology

Definition 1: Ontology O is defined as [9]:

$$O = <c, p, a>$$

where:

- c is a set of named concepts
- p is a set of properties
- a is a set of axioms

The triple in Definition 1 is corresponding to OWL. Here, the set 'a' is the constraints and rules that are defined on the concepts and properties.

The essential steps to consider when engineering an ontology are the following [10]:

- Determining the domain of the ontology
- Enumerating important terms of the domain
- Defining classes in the ontology
- Arranging the classes in a taxonomic (superclass-subclass) hierarchy
- Defining the properties of each class and describing their permitted values
- Creating individual instances

Figure 1 displays a part of the classes and properties that were created using Protégé [11].

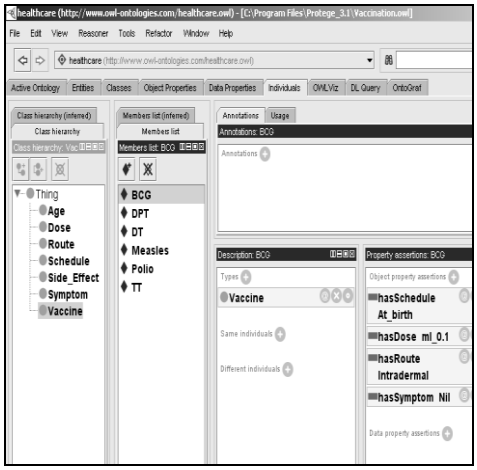

Figure 1: Sample classes and properties created using Protégé

Figure 2 gives a graphical representation of a part of the healthcare domain ontology. Figure 3 shows the corresponding OWL file that is generated.

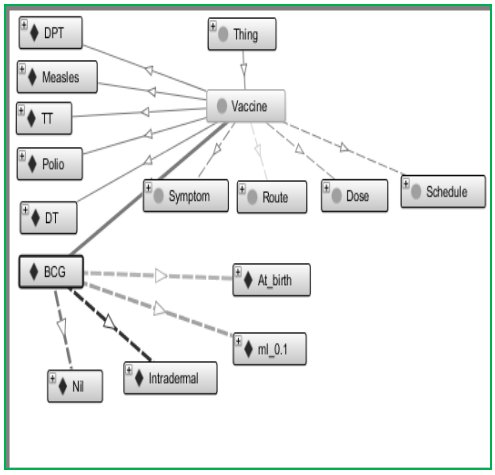

Figure 2: Part of Healthcare (Immunization) ontology

```
  <owl:Class rdf:ID="Age"/>
  <owl:Class rdf:ID="Vaccine"/>
  <owl:Class rdf:ID="Dose"/>
  <owl:Class rdf:ID="Route"/>
  <owl:Class rdf:ID="Schedule"/>
  <owl:Class rdf:ID="Side_Effect"/>
  <owl:Class rdf:ID="Symptom"/>
  <owl:ObjectProperty rdf:ID="hasRoute">
    <rdfs:domain rdf:resource="#Vaccine"/>
    <rdfs:range rdf:resource="#Route"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty
rdf:ID="hasSchedule">
    <rdfs:domain rdf:resource="#Vaccine"/>
    <rdfs:range rdf:resource="#Schedule"/>
  </owl:ObjectProperty>
  <owl:ObjectProperty rdf:ID="hasSymptom">
    <rdfs:domain rdf:resource="#Vaccine"/>
    <rdfs:range rdf:resource="#Symptom"/>
  </owl:ObjectProperty>
  <owl:FunctionalProperty
rdf:ID="hasDose">
    <rdfs:domain rdf:resource="#Vaccine"/>
    <rdfs:range rdf:resource="#Dose"/>
    <rdf:type
rdf:resource="http://www.w3.org/2002/07/ow
l#ObjectProperty"/>
  </owl:FunctionalProperty>
  <grounding:WsdlAtomicProcessGrounding
rdf:ID="WsdlAtomicProcessGrounding_8"/>
```

Figure 3: Sample OWL code

Step 2 & 3:

As a step towards the realization of Semantic Web Services, we have used OWL-S IDE [12]. The OWL-S IDE is an Eclipse plug-in providing an integrated development environment (IDE) to support Web Service developers in both the implementation of Web Services and in the generation of OWL-S descriptions of their Web Services.

Ontology for Web Services

Definition 2 : A Web service is defined as:

$$Service\ (d, f, p)$$

where:

- Service is a Web service that supports semantics
- d is the basic information about Service, including name, ID, provider ID, taxonomy etc.

- f is the functional information about Service, including the set of input/output data etc.
- p is the performance information about Service, including concerned non-functional properties

Semantic Web service can be created using either Code-driven or model-driven approach. Our implementation follows the Code-driven approach [13]. The essential steps of this approach are:

- Develop the implementation of a Web Service through the Eclipse environment.
- Generate a WSDL description of the service from the complete Web Service implementation.
- Generate an OWL-S description of the Web Service from WSDL.
- Develop an OWL-S ontology to describe the Web Service using OWL ontologies.
- Publish a service description with UDDI.
- Deploy the Web Service by publishing the Web Service implementation, WSDL and OWL-S descriptions on a Web server.

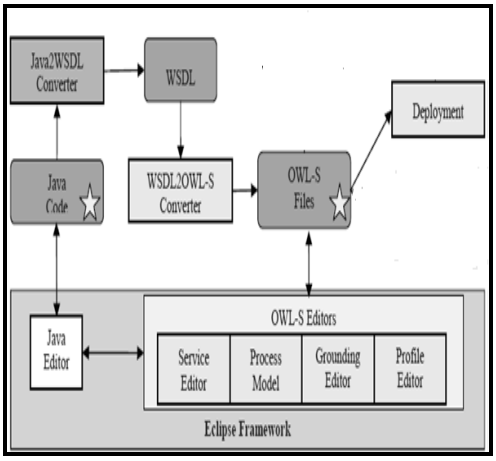

Figure 4: Creation of Semantic Web Services

Figure 4 shows the activities carried out during development of semantic web services using Eclipse [14] and its OWL-S IDE plug-in.

Figure 5 shows a sample web service and the corresponding OWL-S files created using Eclipse and OWL-S IDE.

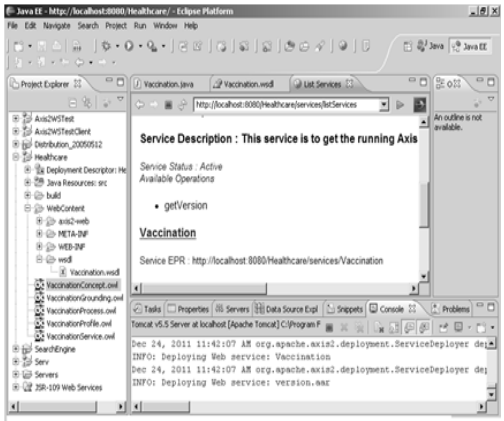

Figure 5: Sample Web service and its OWL-S files created using Eclipse

Figure 6 shows the OWL-S process editor and Figure 7 shows a part of the OWL-S Profile code created for the web service.

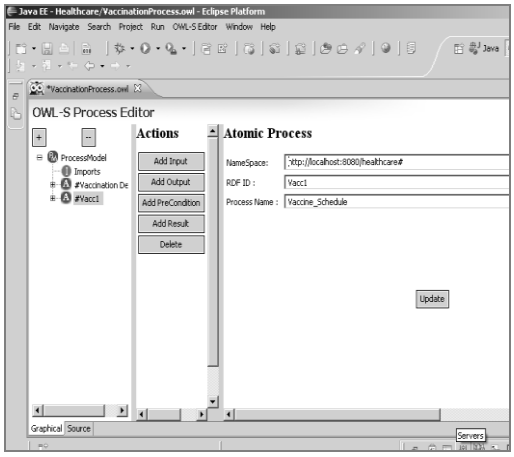

Figure 6: OWL-S Process Editor

```
<profile:hasInput>
 <process:Input rdf:ID="Vaccine_Name">
            <process:parameterType
rdf:datatype="&xsd;#anyURI">
&concept;#Vaccine_ScheduleTypeDeclaration
</process:parameterType>
                </process:Input>
            </profile:hasInput>
            <profile:hasOutput>
                <process:Output
rdf:ID="Schedule">
<process:parameterType
rdf:datatype="&xsd;#anyURI">
&concept;#Vaccine_ScheduleResponseTypeDecl
aration
</process:parameterType>
                </process:Output>
            </profile:hasOutput>
       </profile:Profile>
```

Figure 7: Sample OWL-S Profile Code

We have used the code-driven approach, where the web service is implemented using Java, and the OWL-S descriptions are derived from the code using the WSDL2OWL-S converter. The OWL-S description generated in this approach is missing semantics and, therefore this description is added using the OWL-S editors.

6. CONCLUSION

A new insight into e-immunization application with shift in paradigm from the Web-based Health Management Information System accessible only by health workers and registered users to enhancements using Semantic web services and accessible to common man is proposed. This shall ensure that the health system benefits, that health workers benefit and that the people who make use of the health system – the patients and citizens benefit and their health improves. This will lead to an improved e-immunization programme. Although the recommended web services are expressed simply here, the complexity of putting them into practice is a challenge. But once implemented and adapted, it will go a long way in assisting users get information regarding health matters, enabling access to vaccination schedules through web services, strengthen immunization programme, and in the end improve the health of the population at a much reduced cost.

7. REFERENCES

[1] The Wall Street Journal, India, August 4, 2011, India Turns to Mobile Phones in Bid to Improve Vaccination Rate

[2] Suresh Sharma Immunization coverage in India http://iegindia.org/workpap/ wp283.pdf

[3] http://tnhmis.org/hmis/

[4] Anju Sharma - Mapping Health Level 7 Reference Information Model to Web Ontology Language – 2006

[5] www.obitko.com/tutorials/ ontologies-semantic-web/what-is-ontology.html

[6] S. Bechhofer et al. - OWL Web Ontology Language Reference http://www.w3.org/TR/owl-ref/:W3C Recommendation, 10 February 2004.

[7] Carlos Pedrinaci et al. - Semantic Web Services, In the Handbook of Semantic Web Technologies Vol-2 (Springer 2010)

[8] D. Martin et al. OWL-S: Semantic Markup for WebServices. http://www.w3.org/Submission/ OWL-S: W3C Member Submission, 22 Nov. 2004

[9] Qizhi Qiu, Qianxing Xiong: An Ontology for Semantic Web Services. HPCC 2007: 776-784

[10] Natalya F. Noy and Deborah L. McGuinness. Ontology Development 101: A Guide to Creating Your First Ontology: http://protege.stanford.edu/publications/ontology_development/ontology101-noy-mcguinness.html

[11] A Practical Guide to Building OWL Ontologies Using the Prot´eg´e-OWL Plugin and CO-ODE Tools - http://owl.cs.manchester.ac.uk/tutorials/protegeowltutorial/

[12] Rudi Studer – Semantic Web Services Concepts, Technologies, & Applns - Springer

[13] Massimo Paolucci et al.- CODE: A Development Environment for OWL-S Web services – Oct. 2005

[14] Eclipse. http://www.eclipse.org.