A Critical Study on Semantic Web Systems and Semantic Web Services

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Abstract: The World Wide Web is the greatest repository of information having a decentralized design in which web pages are hosted by numerous computers, where each document can point to other documents, either on the same or different computers. As a result, individuals all over the world are able to provide content on the Web, allowing the growth exponentially as more and more people learn how to use it. However, it is difficult for machines to process and integrate this information meaningfully, so to process a web page intelligently, a computer must understand the data, and it is possible in Semantic Web. Relational database (RDB) is normally used for traditional data processing, whereas Extensible Markup Language documents (XML Documents) are widely useful for performing online conversation in B2B applications. In fact XML data formats may be treated as de facto standard of data representation and exchange format for massive amount of enterprise information over the web. Performance of the application depends on both type of the data structures used and the type of the information maintained in the structures. In this paper some semantic web concepts, different layers of Semantic web architecture, Web services and Semantic web services are presented.

Key words: Semantic Web, XML, RDF, Ontology, OWL.

1. Semantic Web and World Wide Web
“The Semantic Web is not a separate Web but an extension of the current one, in which information is given well-defined meaning, better enabling computers and people to work in cooperation”. The Semantic Web brings structure to the meaningful content of Web pages, creating an environment where software agents, roaming from page to page, can readily carry out sophisticated tasks for users. In the Semantic web, reuse appears not only at the data level, but also at the application level, as nowadays there is much open software from a wide range of sources that can be reused when building Semantic web applications. In the application level reuse follows three different approaches: 1) a distributed services approach: by integrating web service technology in their architectures; 2) a shared memory approach: by composing components that use a shared space of common memory to communicate as in the case of reusing libraries inside an application; and 3) and a mixed approach: by combining the above two approaches.

The Semantic Web (SW) is best understood in comparison to the World Wide Web (WWW). Rather than being a substitute for the WWW, the Semantic Web extends it through useable, standardized semantics that draw deeply on academic research in knowledge representation and logic to approach the goal of ubiquitous automated information sharing. The WWW consists primarily of content for human consumption. Content links to other content on WWW via the Universal Resource Locator (URL). The URL relies on surrounding context (if any) to communicate the purpose of the link that it represents; usually the user infers the semantics. Web content typically contains formatting instructions for a nice presentation, again for human consumption. WWW content does not have any formal logical constructs. Correspondingly, the Semantic Web consists primarily of statements for application consumption. The statements link together via constructs that can form semantics, the meaning of the link. Thus, link semantics provide a defined meaningful path rather than a user-interpreted one. The statements may also contain logic that allows further interpretation and inference of the statements. The flexibility and many types of Semantic Web statements allow the definitions and organization of information to form rich expressions, simplify integration and sharing, enable inference, and allow meaningful information extractions while the information remains distributed, dynamic, and diverse. Simply put, the Semantic Web improves your application’s ability to effectively utilize large amounts of diverse information on the scale of the WWW. This is accomplished a structured, standardized approach for describing information so as to allow rich information operations.

2. The Semantic Web Layer Architecture
The overall architecture of the Semantic Web (SW) is presented in figure 1. It is divided into five layers namely Syntactic Layer, Metadata Layer, Ontology Layer, Logic Layer and Trust & Proof Layer. Each layer performs a set of duties and a set of technologies associated with them. The technical details of each layer with their representational capabilities are presented in the following sub-sections.

2.1 Syntactic Layer
Syntactic layer represents the web documents as abstraction of information that can contain a hierarchical structure of information. XML is the technology used to represent hierarchical structure of information in this layer, to grant syntactic interoperability. XML uses Uniform Resource Identifier (URI) and Internationalized resource Identifiers (IRI) for making everything language-independent. These technologies XML, URI and IRI together allow structuring, correct representation, and correct referencing of data for Web applications.

2.2 Metadata Layer
In the next layer Metadata Layer, the Semantic Web uses a simple XML-based data model namely Resource Description Framework (RDF) for the description of resources and their types. In this model any type of content can be uniformly described through subject-predicate-object triples. To make machine understandable it needs to define the meaning to the existing web content. The Metadata layer is responsible to provide a well defined meaning to the content of the Web document. Metadata may be referred as data about Web pages, abstract resources and everything that can be identified by any URI.

2.3 Ontology Layer
Ontology layer adds a shareable and common semantics to the existing meta-data without conveying any information about how to use concepts and relationships defined in the Ontologies. Ontologies represent the most central component of the Semantic Web and it is a necessary framework for granting a common metadata vocabularies understanding among applications. RDF schema is used to describe ontology formalisms. Ontology makes resources machine processable and understandable and hence fulfils the main goal of Semantic Web.

2.4 Logic Layer
Logic layer is added for specifying the meaning of the components and terms included in ontology. Logical languages namely Web Ontology Language (OWL) and Description Language (DL) are used for defining the formal semantics of the ontology. OWL is used for data representation, and Description Languages (DL) is used for reasoning operators to reason about the data. Semantic Web Rule Language (SWRL) is currently exploring the possibility of integrating rules and ontologies. SWRL may be extended so that a set of OWL axioms to be combined with an OWL knowledge base.

2.5 Trust and Proof Layer
Trust and proof is the top goal for the development of the Semantic Web. All the technologies mentioned above are used for automated integration of information, eliminating inconsistencies or incompleteness, and consolidating distributed information from the Web. If they are accompanied with proper security, verification, and encryption mechanisms then Semantic Web shall provide enough trust on the information required for the users.

3. Web Services
A Web service is a self-contained, modular, distributed, dynamic application accessible through Internet protocols like HTTP or SMTP and uses a standardized XML messaging system. Web Service enables a distributed environment that can be described, published, located, or invoked over the network to create products, processes, and supply chains. A Web service model includes three component roles: the service requesters who invoke services, the service providers who offer services and respond to the requests, and the registries where services are published. Some of the web services are fund transfer, get balance and get customer information services in Internet Banking Application system, seat availability, booking ticket, cancel ticket and check PNR status services in Online Reservation system Application.

Web services consist of three phases as shown in fig 2 namely publishing, finding and binding.
services. A service provider publishes the description of the service it offers to a service registry. Such description contains information about the service provider like company name, address and contact information, and contains information about the service itself like name and category, and also contains the URL of its interface definition. When a service requester needs for a service, it finds the desired service either by expressing a query, or directly browsing the registry.

The service requester interprets the meaning of the interface description of the discovered service by exploiting variables names, comments and additional documentation and then binds such service within the application. When a service requester binds a service, it includes an invocation of such service within the application. The requester invokes the discovered service by means of the Web service communication protocol.

The components required for accomplishing the usage activities are included in SWS architecture. In SWS architecture there are three components namely reasoner, register, and matchmaker. Reasoner provides the reasoning support for interpreting the semantic descriptions and queries. Register provides a mechanism for publishing and locating services in a semantic registry. Matchmaker provides an interface between the requester and the register to discover and select the service.

The Semantically Web Service includes three component roles namely usage activities, architecture and service ontology. The details of the model are presented in fig 3.

Figure 3: Semantic Web Services Infrastructure
There are three usage activities in SWS web service applications. They are publishing, discovery, selection. In SWS applications these usage activities are treated as objects. Publishing SWSs will allow agents or applications to discover services based on its goals and capabilities. Service discovery provides semantic matching between the description of a service request and one of the published services. If there are more than one service is available for the same request then the object selection of services resolves based on non-functional attributes such as cost or quality.

4. Semantic Web Services
Semantic Web Services (SWS) are typical server side applications of a client–server system for machine-to-machine interaction on the World Wide Web. They provide intelligent web services to the users. Some of the Semantic Web services are storing, sorting, and presenting media data in Media Management application about BBC 2010 world cup website and services like seismic measurements, well records, drilling figures, transportation numbers, and marketing statistics in Data Integration application related to Chevron’s Oil & Gas Company.

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5. Conclusions
In summary, this paper aims to review the development of Web Services and Semantic Web Services. Based on the discussed part of the study, it seems that SWSs will, at some point in time, be relevant with respect to certain integration problems. They will be dealing with one of the key bottlenecks in modern networked society: interoperability. We expect a strong demand for SWSs and integration technologies based on them as businesses react to the need for a higher level of integration and more agility. Making disparate systems
share information cost-effectively is a key problem for many companies and represents billions of euros in technology spending, with a high percentage of worldwide IT budgets dedicated to enterprise integration projects. SWSs promise to integrate application services that are encapsulated in both old and new applications. Enterprises will not only be able to move information from application to application, but also to create composite applications by combining services found in any number of different local or remote application systems.

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