ADAPTATION OF SEMANTIC WEB TO RURAL HEALTHCARE DELIVERY

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ABSTRACT

Presently, computers are changing from isolated devices to a worldwide network of information exchange and business transactions called the World Wide Web (WWW). However, the success of the WWW has made it increasingly difficult to find, access, present and maintain the information required by a wide variety of users. In response to this problem, many new research initiatives and commercial enterprises have been set up to enrich the available information with machine-processable semantics. As a response to the challenge of providing high quality healthcare services with reasonable costs while the elderly population and the associated chronic disease increase, this paper provides a conceptual model (Semantic health model) of using the Semantic Web to locate required information regarding health matters, thereby facilitating healthcare delivery in rural areas. This Semantic Web will provide intelligent access to distributed information, enabling software products (agents) to mediate between user needs and the information sources available. The Semantic health model will consist of four layers: Database, Data Transfer Mechanism (DTM), Medical Inference Engine (MIE) and User interface.

Keyword: Database, Healthcare, Inference engine, Semantic web, User-interface.

1.0 INTRODUCTION

Semantic web is an evolving extension of the World Wide Web (WWW) in which web content can be expressed not only in natural language, but also in a form that can be understood, interpreted and used by software developers, thus permitting them to find, share and integrate information more easily.

The Semantic web is an idea of www inventor, Tim Berners-Lee, a software engineer who believed that the Web as a whole can be made more intelligent and perhaps even intuitive about how to serve a user's needs (Berners-Lee T. et al, 2001). He knew that there had to be a better way to keep track of information about what people were working on. So the proposal on the semantic web was started in 1989.

The goal of the Semantic Web, with its vision by T. Berners-Lee is to develop expressive languages to describe inform-ation in forms understandable by humans and machines (Berners-Lee T. et al, 2001).

2.0 OVERVIEW OF SEMANTIC WEB

The World Wide Web (WWW) has drastically changed the availability of electronically accessible information. The WWW currently contains some 3 billion static documents, which are accessed by over 300 million users internationally. However, this enormous amount of data has made it increasingly difficult to find, access, present and maintain the information required by a wide variety of users. This is because information content is presented strictly in human readable form. Thus, a wide gap has emerged between the information available for tools aimed at addressing the problems above and the information maintained in human-readable form.

In response to this problem, many new research initiatives and commercial enterprises have been set up to enrich available information with machine-processable semantics. Such support is essential for "bringing the web to its full potential". Tim Berners-Lee, Director of the World Wide Web Consortium, referred to the future of the current WWW as the "*semantic web*" - an extended web of machine-readable information and automated services that extend far beyond current capabilities (Fensel D. and Musen M., 2001). The explicit representation of the semantics underlying data, programs, pages, and other web resources, will enable a knowledge-based web that provides a qualitatively new level of service. Automated services will improve in their capacity to assist users in achieving their goals by "understanding" more of the content on the web and thus providing more accurate filtering, categorization and searching of information sources. This process will ultimately lead to an extremely knowledgeable system that features various specialized reasoning services. These services will support rural areas in nearly all aspects of daily living -making access to information as pervasive and necessary as access to electricity is today.

As the Web was implemented using Uniform Resource Identifiers (URIs), HyperText Transfer Protocol (HTTP) and HyperText Markup Language (HTML), the Semantic Web is built with URIs, HTTP, Web Ontology Language (OWL) and Resource Description Framework (RDF). We will discuss each of these briefly.

URIs: The URIs are acronyms for Uniform Resource Identifiers, they are text strings that identify resources, or concepts. Commonly referred to as Uniform Resource Locators (URLs), they come in many forms (and are extensible, so that new forms can be created) and identify many things.

HTTP: The HTTP is a system for perfor-ing operations on resources (identified by URIs). It is widely implemented, and is the protocol all Web browsers and servers speak. It has three major "methods", or types of actions it can perform: GET, POST and PUT.

a) GET asks for information about a resource. POST sends a request to a resource. PUT sends updated information about a resource.

By using HTTP, Semantic Web services get all of this functionality for free. It's already built-in to the many HTTP servers and clients that are available for lots of platforms in almost every programming language.

Web Ontology Language (OWL) is intended to be used when the information contained in documents needs to be processed by applications, as opposed to situations where the content only needs to be presented to humans. OWL can be used to explicitly represent the meaning of terms in vocabularies and the relationships between those terms. This representation of terms and their interrelationships is called ontology. OWL has more facilities for expressing meaning and semantics (Smith K.M. et al, 2004).

RDF: the Resource Description Framework is the major new piece of the Semantic Web. It's a format for providing information in machine-readable form, using URIs and text strings as terms. So Semantic Web Services combine URIs, HTTP and RDF to build a system of machine-to-machine communications for sharing information.

3.0 APPLICATIONS AND FUTURE OF THE SEMANTIC WEB

3.1 Applications of Semantic Web

Though the Semantic Web is still in its infancy, there are a number of useful

Semantic Web Services available already. MusicBrainz, for example, allows users to POST music metadata to their database so that other users can GET it. They use RDF for both procedures, and this functionality is built into the the FreeAmp MP3 player. When an audio CD is opened with Free-Amp, it queries the MusicBrainz server for track name and artist metadata about the CD, so that tracks can be select by their name, in addition to just their position on the CD.

The Open Directory Project provides the contents of their massive web site categorization in RDF. A number of other providers, such as Google have integrated this data into their site, combining it with their own databases. The Google Directory, for example, annotates the category listings with the Page Rank information that makes Google searches so accurate. It's things like these, where two independent sources of data are combined to make something more useful than either is on its own, which is likely to become more prevalent as Semantic Web development continues.

Other applications of semantic web in real life applications includes; the British Telecom Call Center, Swiss life and EnerSearch applications.

3.2 Future of the Semantic Web

In developing countries like Nigeria, the semantic web technology is still in its early stage. Semantic Web Services are far from the end of the Semantic Web vision. There's quite a bit of interesting research and development still going on. We will discuss some important issues of the semantic web; Aggregation, Security and Logic.

3.2.1 Aggregation

Systems like Google aggregate the many pages of the Web into a cohesive database you can search. Developers are working on similar systems for RDF data, to create a sort of Semantic Google called Swoogle. There are two main approaches: the centralized one, where all the data is collected onto one system; and the decentralized one, where the data is organized across many computers, each taking responsibility for a different portion. One of the important parts of the aggregation process is keeping track of who said what and grouping of data could be used for example. Once this is taken care of, RDF databases can use this information to better answer queries. For an ever-changing fact, like the temperature, you'll want the latest information. An RDF database can search to find the latest statements and pick the most recent statement of temperature.

3.2.2 Security

If we are combining all of these RDF statements together, there comes the issue of whether we can trust them. RDF trust is based on the way human trust works. We build rough "trust networks" by picking a bunch of friends (who we mostly trust), and then their friends (who we trust a little less), and then **their** friends (who we trust even less) and so on. RDF does a similar thing by building a "Web of Trust", taking into account who you trust and how much you trust them. By connecting these statements with everyone else's, it builds a Web that interconnects almost everyone. RDF also uses digital signatures to ensure that the triples were actually said by who they're claimed to be said by.

3.2.3 Logic

Logic provides a way for you to express **rules** that take in triples and output new ones in RDF. It's based on the old field of symbolic logic, and has strong mathematical backings. Logic makes use of ontology and the principle of inference (The principle of "inference" is quite a simple one: being able to derive new data from data that you already know).

3.2.4 Ontology

This is considered as one of the pillars of the Semantic Web, although they do not have a universally accepted definition. Ontology is a formal specification of a shared conceptualization.

Ontology technology – the knowledge representation and inference core of the Semantic Web – promises this wide applicability (Berners-Lee T, et al 2001).

DARPA Agent Markup Language (DAML) is a language created by Defense Advanced Research Projects Agency (DARPA) as an ontology and inference language based upon RDF. DAML takes RDF Schema a step further, by giving us more in depth properties and classes. DAML allows one to be even more expressive than with RDF Schema, and brings us back on track with our Semantic Web discussion by providing some simple terms for creating inferences.

3.2.5 Inference Engines

These are the tools that take in rules and data and process them, writing out the resulting RDF triples. Programming using rules is what is called declarative programming, and is often simpler than writing out code to do the work. It also makes it easy for others to use your rules, and since rules are just RDF, you can have rules that operate on rules. In the future, it's possible that there will be inference engines searching through the Web, looking for interesting inferences to make.

4.0 HEALTHCARE DELIVERY AND ADAPTATION OF SEMANTIC WEB

4.1 Healthcare Delivery in Rural Areas

Rural or remote areas are those which possess more than one of the following features: Shortage or lack of electricity supply, basic infrastructure, bad roads, low per capital income, severe weather conditions, shortage of telephone and telecommunication service, lack of health-care treatment service and medical specialists which has led to increase in mortality rates of patients suffering from various diseases. Health-care delivery in rural areas of Nigeria is suffering due to the problems mentioned above. Difficulty in seeing medical practitioners cannot be overemphasized and most medical practitioners may not have enough expertise or experienced to deal with certain high-risk disease. However, the waiting time for treatments normally takes a few days, weeks or even months. By the time the patients see the specialist, the diseases may have already spread out. As most of the high-risk disease could only be cured at the early stage, the patients may have to suffer for the rest of their lives. A proposed solution to solve the problems of shortage of electricity supply and telecommunication services is the use of a combination of Power Generators, Solar Energy and VSAT-WLL (Very Small Aperture Terminal and Wireless Local Loop) Technology.

The application of Semantic web could be used to reduce the waiting time to see the specialist and thereby reduce the number of mortality rate by providing intelligent access to distributed information, enabling software products (agents) to mediate between users needs and the information sources available through the World Wide Web (WWW) .

4.2 Adapting Semantic Web to Rural Areas Health Care Delivery

Following the problems facing healthcare delivery in rural areas the writers of this paper propose a concept on how the Semantic web can be used to provide healthcare delivery in rural areas. Knowing that the main power of Semantic Web language is that any one can create one simply by publishing some RDF and Extensible Markup Language (XML) that describes a set of URIs, what they do and how they should be used. The RDF Schema and DAML are very powerful languages for creating languages, since the URIs is used for each of the terms in the languages, it can then be published (on the Web) without fear that they might be misinterpreted or stolen, and with the knowledge that anyone in the world that has a generic RDF processor can use them. By bearing in mind that to cover wide range of situation it is important that a powerful logical language (combining rules of logic and mathematical backings) can be used for making inferences. The Inference engines then takes in rules, data and process them writing out the results following sets of programming rules and thereby providing inference engines that will search through the web, looking for interesting inferences to generate solutions to health problems.

This paper presents a proposed Semantic health model which consists of four (4) layers: Database, Data Transfer Mechanism (DTM), Medical Inference engine (MIE) and User Interface.

4.2.1 Database

The database layer contains database on personal health data (Personal health record) of patients such full name, date of birth, medical history (examination results, diseases and drugs), etc which will be fed by the patients manually or by the hospital or clinic responsible for the patients through the data transfer mechanism.

4.2.2 Data transfer Mechanism (DTM)

The Data Transfer Mechanism (DTM) is important in many environments especially in rural areas. This mechanism can be facilitated (processed) by installing internet facilities.

4.2.3 Medical Inference Engine (MIE)

The MIE will serve as the semantic web search engine. MIE is made by performing some RDF, XML and some mathematical rules on the data transferred to it and these data will be queried through API's on languages such as Java, PHP and Ruby. In addition SPARQL can also be used to query and manipulate data on the semantic web too. The MIE uses the data of the personal health record (PHR) as fed and an Expert system to generate appropriate advice and suggestions where necessary.

4.2.4 User interface

The user interface is very easy to use, it is designed to serve different user needs depending on the Patient health records (PHRs), in the case where they don't have one existing, then they will be asked to fill in the registration form and then all necessary information is saved into the database for the future use. Also it will play a vital role in promoting and assisting a sustained interest in health topics related to individuals needs.

By adapting Semantic health model to rural areas, Healthcare delivery will be easier, fast, death rate will be reduced and the spread of diseases will be minimized (Figure1).

Inference Engine and ***HTTP*** *represents Hypertext transfer protocol,* ***PHR*** *represents Patient Health Records. Where* ***DTM*** *represents Data Transfer Mechanism,* ***MIE*** *represents Medical*

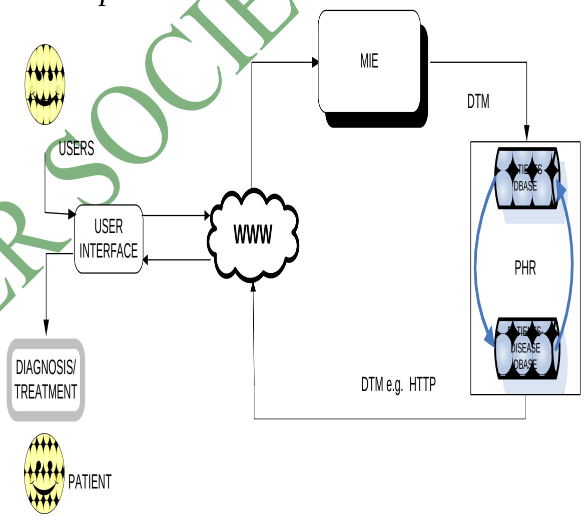

Figure 1: Semantic Web Health Model

5.0 CONCLUSION

The Semantic Web will bring 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. Such an agent coming to the clinic's Web page will get information relating to health matters. 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 easy information access based on the success of the web has made it increasingly difficult to find, present and maintain the information required by a wide variety of users.

In response to this problem, many new research initiatives and commercial enterprises have been set up to enrich available information with machine-understandable semantics. This Semantic Web will provide intelligent access to distributed information, enabling software products to mediate between user needs and the information sources available. The existence of XML and RDF, along with developments such as RDF Schema, provides the impetus for realizing the Semantic Web.

The conceptual model (Semantic health model), if adapted in rural areas, will go a long way in assisting users get information regarding health matters, enabling access to data from providers of health services, strengthen health promotion, and in the end improve the health of the population with reduced cost rate.

The future of the semantic web is filled with lots of good things and expectation.

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