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Abstract

The architectural landscape of healthcare information systems is extremely diverse representing a collection of many different hardware and operating platforms as well as applications developed in a multitude of development environments and programming languages. The real struggle in healthcare information technology is the need to find means to expand the effective use of these existing systems while at the same time increasing their functional capabilities. One answer to this dilemma is the Web Services model. Web services are application modules that provide the underlying technologies necessary to exchange data and other services between applications residing on the Internet. Standards used to support the Web services model include the XML based specifications of UDDI for discovery of Web services, WSDL for describing Web services and SOAP for transporting messages and exchanging data. Given all the interest in this technology and the projected benefits Web services will bring to healthcare technology, it would be expected that healthcare organizations are embracing the Web services model. The purpose of this research project is to assess what is happening in the healthcare arena in relation to Web services. The first part of this project, which is presented in this paper, is to investigate the availability of published healthcare related Web services. The next phase of the research will be to identify specific healthcare organizations that are developing Web services and assessing how those Web services are being implemented.

Introduction

Information systems are becoming increasingly complex and this is especially true with healthcare systems. A modern information system is often implemented as a number of cooperating software processes and applications that operate within multi-layer, multi-platform environments. The architectural landscape of healthcare information systems is extremely diverse representing a collection of many different hardware and operating platforms as well as applications developed in a multitude of development environments and programming languages. For instance, traditional healthcare information systems reside on hierarchical databases that provide vertical integration to application solutions. Given the economic constraints currently facing healthcare and the monumental efforts required to convert large masses of data, these legacy systems will remain in use in healthcare for, at least the foreseeable future. Compounding this is the federal mandate that healthcare organizations must comply with the Health Information and Portability Accountability Act (HIPAA) requirements to insure the privacy and security of protected healthcare information. This has driven the focus in healthcare to move systems towards adherence to these standards by evolution of existing systems rather than embarking on brand new initiatives. Therefore, the real struggle in healthcare information technology is and will continue to be the need to find means to expand the effective use of existing data stores and currently deployed information technologies.

In the past, the model for the development of healthcare software systems was focused on the large software project. These were often viewed as one-of-a-kind systems that took years to build, were continuously upgraded and released back to the user community on an annual cycle. This type of development is no longer practical. The trend is towards developing more concurrent, more distributed, and more connected applications in shorter periods of time. This interconnectivity of computer resources expands the horizons such that sophisticated computer applications can be built upon a collection of small functional software components combined together with each other and with legacy systems in various ways to solve a multitude of problems. In addition, the widespread adoption of the Internet as the foundation of universal computer connectivity has generated new opportunities for further collaboration.

The advent of the Web services technology model provides a means to support the integration of disparate applications running in heterogeneous environments. Web services are application modules that provide the underlying technologies necessary to exchange data and other services between applications residing on the Internet. The idea is to view these functional components as services that can be connected together to create a complete business process. The Web services infrastructure supports the interchange and interoperability of these services between different participants (vendors, business partners, etc.). There has been much hype surrounding this evolving technology and there is a great expectation that Web services will mature into all that this technology promises. According to Laroia (2002), "The Web services model enables healthcare entities to make investments that mitigate confusion among data standards and technology specification semantics" (p. 47). Further, he states that "employing a Web-services-based framework also enables healthcare organizations to become technology- and data-independent" (Laroia, 2002, p. 47). Given all the interest in this technology and the projected benefits Web services will bring to healthcare technology, it would be expected that healthcare organizations' technology initiatives are embracing the Web services model. The purpose of this research is to assess what is happening in the healthcare arena in relation to Web services. The initial work, as presented in this paper, was an investigation to determine if there is evidence supporting the availability of Web services technologies within the healthcare arena. The next phase of the research will be to identify healthcare technology companies that are actively incorporating Web services into their product offerings, which healthcare organizations are the first adopters of the Web services model and what types of initiatives are underway and whether the implementation of those Web services adhere to Web services standard technologies.

Definition of Web Services

Web services are defined as interoperable service components that can be accessed as necessary to perform or complete a business process. Within healthcare, there are many functions and independent processes that can easily be supported by a Web services model. For example a patient episode of care might be facilitated with automated Web services support for appointment scheduling and appointment reminders, eligibility confirmation, insurance claim forms verification as well as encounter and billing data validation. Each of these potential Web services promotes the flow of data and information between the many entities involved in completing the business processes associated with a patient visit.

Web services are characterized by the ability to dynamically create and discover services and deliver those services over the Internet. The basic architecture of a Web service is built around functional components supported by Internet compatible technologies. Because the Web services model is built on the assembly of services, the core functional component is usually designed to support one main function or task. The desire is for developers to be able to develop the core component of the Web service in whatever programming language they desire because users of the Web service will not interact directly with the executable. The Web service core component is then wrapped inside a Web service interface that eliminates the need for translation of the core component. Interoperability for Web services means that they must adhere to a set of standards to facilitate the connections between the services and these standards include basic Internet/Web protocols such as HTTP, XML and SOAP.

The basic mechanisms required in utilizing a Web service include discovery, description and invocation. Standards for each of these methods have been defined with the underlying technology being the eXtensible Markup Language (XML). Discovery facilitates identifying the location of the Web service. If the location of the Web service is known, this step can be bypassed but the real goal is to automate this process. The Universal Description, Discovery and Integration (UDDI) specification, overseen by the OASIS Standards Consortium, provides a standard that allows for the registration and discovery of available Web services (OASIS, 2003). Description provides a standard way to describe the nature of the Web service and its required parameters. This is done using the XML based Web Services Description Language (WSDL) overseen by the World Wide Web Consortium Web Services Description Working Group. Invocation defines the calling procedures and methods provided by the Web services core software component. Invocation is supported through the SOAP protocol overseen by the World Wide Web Consortium XML Protocol Working Group.

The UDDI standard outlines a framework for a registry of companies and a warehouse of the listings of the Web services they offer. The initiative has been in place since 2000 with the goal of providing a public and global infrastructure for businesses, including healthcare providers, to make themselves and their services known and a way for those seeking services to find them. Currently there are four public registry nodes operated by IBM, Microsoft SAP and NTT based in Japan. The UDDI provides both a user interface for manual search and a programmatic interface for automated searching. While this public initiative expands the idea of accessibility, its growth has been much slower than expected. The UDDI specification does not have to be utilized in a public arena; it can be employed 'privately' for in-house purposes. However it is the public UDDI that is intended to be the focal point for locating services that reside outside an organization's internal network.

While the requester or a Web service does not need to know the basics about how the core functional component is implemented, they do need to know other things about the service. This is achieved through the Web Services Definition Language (WSDL) that is a standard written in XML that describes the Web service. Each Web service will have an associated WSDL file. Basically the WSDL serves four purposes: provides interface information for all publicly available functions, provides data type information for all parameters associated with message requests and returns value type of all message responses, provides binding information about the transport protocol and provides information for locating the service (Cernani, 2002). In essence, the WSDL describes both the input and output message parameters for interacting with the functions and operations of the Web service and also how those messages will be transported. The information garnered from the WSDL file will be used to generate the SOAP request that is used to invoke the functional component of the Web service.

SOAP is an XML-based protocol used to exchange structured information across distributed environments and a primary benefit of SOAP is that it can be used in combination with HTTP, the transport protocol of the Internet. The intent behind SOAP is simplicity. It is really a one-way messaging model. For example, a sender might send a SOAP message to a receiver. If a response is requested, the receiver would generate a new SOAP message to be sent back to the original sender. Consequently, while multiple messages can be combined into one SOAP file, the average SOAP message is usually no more than 6-10 lines long. The basic straightforwardness of SOAP allows it to be used in heterogeneous environments, something many of its predecessors found difficult to achieve without adding layers of complexity.

Illustrated Example: Eligibility Confirmation

One activity commonly required within healthcare is for a healthcare provider to determine patient eligibility from a healthcare payor for services to be performed. This type of task is well suited to be executed as a Web service. The process would begin by utilizing a programmatic interface to a UDDI to search for the particular healthcare payor organization that assesses the eligibility for the desired healthcare procedure for this specific patient. Once the Web service has been discovered, a call is made to the Web services provider to retrieve the associated WSDL. If the requester is allowed access to the WSDL, it will be parsed to identify the exact location of the Web service and to determine associated required message parameters. For instance, the payor may require such identifying data as name, social security number, birth date and health plan number service code. The specifications and data type of the return value is also identified. The return value might include the same identifying data followed by an eligibility confirmation number. The result of the WSDL parse is the creation of a SOAP message to invoke the Web service. Encapsulated within the SOAP message are the required input parameters. When the service provider receives the SOAP message, the functional component of the Web service is executed and the return SOAP message is generated and sent back to the service requester, in this case the healthcare provider application. This process is depicted in Figure 1.

Initial Investigation f Published Healthcare Related Web Services

Web services are a fairly new technology but their widespread adoption has been predicted by most experts in the field. Further, while the technology is still evolving, standards for the basic components (UDDI, WSDL, XML and SOAP) of Web services are in place. Expectations are that the healthcare will embrace the Web services technologies. In fact, OASIS who oversees UDDI specifications, specifically cites healthcare providers to be one of the companies that will utilize the public UDDI (OASIS, FAQ, n.d.). Published Web services provide evidence of healthcare's participation in the Web services revolution.

At the current time, Web services that are published are either included in a UDDI or listed on one of the Web services directory sites. This investigation spanned the public UDDI, and three primary Web services listing sites, Xmethods, Web Services List and Remote Methods. The first area reviewed for healthcare Web services was the UDDI. This UDDI network is intended to be the white pages for finding businesses and the yellow pages for finding Web services. The vision is that the public UDDI will become the Web services repository. An assessment of the public UDDI found only 21 listings related to healthcare. Out of these 21 listings, 13 offered no Web service. Of the 7 sites that did list a Web service, 5 were demos or tests (3 of these were for an internal project) and one was a Web Service for caloricity of food consumed by the human body and the other was a Web service to provide a listing of companies within the eye care industry. The 2 demos included an online clinic booking Web service and the other was a medical notes storage and retrieval Web service.

A review of the two major Web services listing resulted in finding 5 Web services related to healthcare. One locates healthcare providers in the USA given a State or Zip Code. The other 4 were related to the coding of medical records and conversion of codes from the ICD-9 to the ICD-10 international classification system.

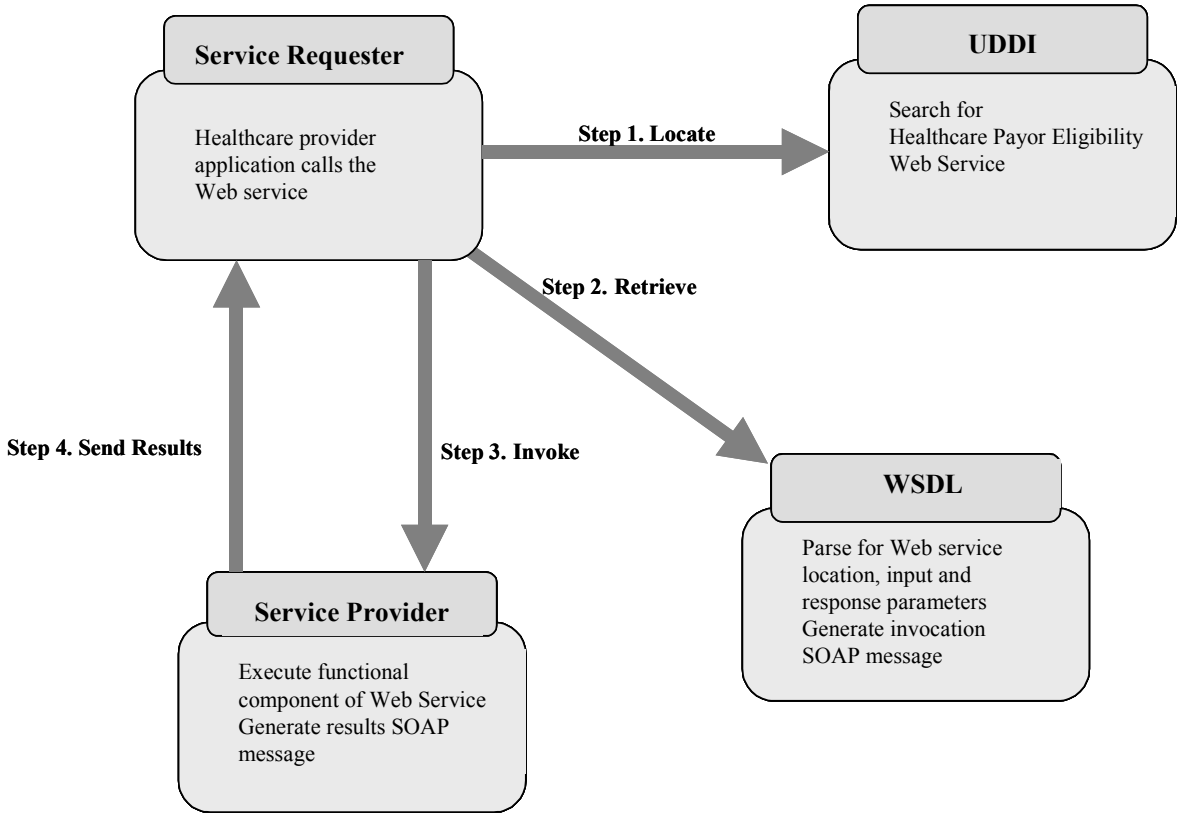

Figure 1. Example Web Service for Eligibility Confirmation

Significance, Continuing Research and Conclusion

With the hype surrounding Web services and their potential benefits, it would be expected that healthcare organizations or at least healthcare technology providers would be visibly promoting their services. However, this was not found to be the case. Given the minimal findings of published healthcare Web services, many questions remain that must be investigated. First, an assessment needs to be made related to the UDDI itself and ascertaining why healthcare organizations are not using this service. Tom Sullivan (2002) of *Infoworld* cites that the information technology research firm, Gartner, believes that the UDDI is still immature but expects improvements in the standards will lead organizations to utilize the service but not before the 2004-2005 timeframe. However, they also cite that they see no alternatives. Therefore, it will be important to assess why healthcare organizations are not utilizing this service.

Second, an assessment needs to be made as to what initiatives are taking place in relation to the development of Web services within healthcare and who is leading this effort. Although few, there have been cases cited such as Providence Health Systems which announced a Web services strategy that includes utilizing Web services for data retrieval, making updates, and for presenting information to users (Karpinski, 2002) and hospital information system vendor Eclipsys incorporating Web services into their computer-based physician order entry system (Marietti, 2002). Many healthcare Web services initiatives might be internal projects but for this technology to gain the presence it needs, organizations will need to go public with their Web services plans. Given the need for healthcare organizations to interact well beyond their internal operations, the true potential of Web services will be realized when they extend to external partners. Continuing research will survey healthcare organizations and healthcare technology vendors to assess the work being done in this area. If Web services are to be a usable technology within healthcare, and all indicators are that Web services are a viable solution for fostering data exchange amongst disparate systems, research initiatives related to their effective use, acceptance, and implementation are paramount to forging better understandings of the potential impact this technology will have on advancing the state of healthcare's use of information technology.

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W3C XML Protocol Working Group: **http://www.w3c.org/2000/xp/Group/#soap**
Web Service List: **http://www.webservicelist.com**
Xmethods: **http://www.xmethods.net**