BIOGRAPHICAL INFORMATION

Tadeo H. Schultz
Senior Consultant
Ajilon Consulting

Specific Responsibilities

Mr. Schultz joined Ajilon Consulting in 6/2003 as a Senior Consultant. He is assigned to National Grid's Outage Management group in Syracuse NY. He is currently involved in the implementation of new functionality for the NGRID GENS/PowerOn system.

Past Experience

Over 18 years of experience in GIS, software engineering, software design, applications development, and technical management, broad range of experience in a variety of application areas that include utilities and telecommunications, oil and gas exploration, and natural resource management.

Educational Information

MS, Geology - Southern Methodist University - Dallas, TX
BS, Computer Information Systems - Regis College - Denver, CO
BS, Geology - Southern Methodist University - Dallas, TX

Professional Memberships

GITA

Tadeo H. Schultz
Senior Consultant
Ajilon Consulting
400 W. Division Street, Suite 102
Syracuse, NY 13204
Phone: (315) 428-5744
E-mail: tadeo.schultz@us.ngrid.com

Revitalizing Enterprise Applications with GIS Web Services and Real Time Data

Abstract

Web services have revolutionized Enterprise Application Integration with the promise of serving and delivering business logic over the net as a coherent discrete service rather than as packaged products. With it also comes true platform and language independent systems, resulting in a large degree of dynamic business interoperability culminating in new business opportunities and greater efficiencies for the enterprise.

GIS is a natural and ideal candidate for web services implementation. Today core GIS functions such as location mapping, and routing are used by a broad spectrum of applications. These functions are request based, and are therefore ideally suited for a web services implementation. This paper reviews current services such as LBS (Location Based Services). Leading standards and frameworks such as SOAP, .NET, ebXML, OpenLS which are the glue that bind and make these services possible and are presented and discussed in the proper context.

Real time data whether it is GPS coordinates, telemetry information such as SCADA inputs, or environmental measurements, are increasingly utilized further driving the need for GIS services. Appropriate and diverse examples such as the integration of real time data telemetry in emergency planning and resource management applications, and the increasing integration of (LBS) in both enterprise and consumer applications are also presented.

Introduction

Software as Services

Today's prevailing IT environment, is one where corporations, enterprises, and organization alike are all pushing applications, media content, and business logic and functionality over the

web in ever increasing numbers. Web development has metamorphosed and matured through the development of tools and methodologies to meet this phenomenal demand. Web Services is the latest milepost in this progression and is best described as a mechanism to distribute or expose business functions over the web. The paradigm of a service is used to encapsulate and distribute business functions, allowing users to subscribe to desired services and for providers to act as the publishers or distributors of them. In effect this creates a new paradigm and further extends the types of interactions that are possible over the web.

The level of functionality available over the web has continued to increase exponentially. Web applications have evolved from simple html formatted text and graphics to complex interactive applications that incorporate a multitude of distributed databases, in an ever increasing blend of client/server interactions. In spite, of the complex nature of many of today's web enabled applications, the web development methodologies have been haphazard and adhoc at best with the overriding concern being to push out content as quickly as possible. It is against this backdrop and because of it that Web Services have evolved.

Enterprise Application Integration

Today's competitive business environment require ever increasing levels of efficiency and integration of information assets in order to realize increasing gains in profitability. EAI (Enterprise Application Integration) as a discipline in the greater arena of integration evolved from RPC (Remote Procedure Call) based approach to the more comprehensive B2BI (Business to Business Integration) and EAI methods, EAI is a discipline which utilizes messaging interfaces and attempts to standardize messages within the domain of the enterprise or organization that it is integrating to achieve results. The correlation between EAI and Web Services is that they both describe solutions to integration problems. They both exploit messaging and standards In the case of Web Services we are dealing only with standards and procedures to web related systems.

Characteristics of Web Services

The following are defining aspects of Web services useful for understanding them and classifying them.

Table 1 : Unique web services characteristics

Aspect	Description
Coarse grained	Interface to component based services
Loosely coupled	Users and providers unaware of implementation details. Language Independent services
Self describing	Standard description inform other systems of details of the service

In addition web services may be classified as:

Table 2: Types of Web Services

Basic Web Services	Collaborative Web Services
Provide a simplistic pattern for interactions, with single requests and responses.	Provide a sophisticated pattern for interactions, with numerous message exchanges.
Have limited security requirements.	Have strong security requirements.
Do not support business collaboration.	Support business collaboration.
Are synchronous and unreliable.	Are asynchronous and reliable.
Are read-only.	Can be read and updated.

(Malks and Sum 2003)

In short and to summarize, all web services can be described as interfaces to components or providers of functionality. They are 'loosely' coupled into an application. We don't want the user to have to know intimate details concerning the implementation but merely to be able to utilize them as one would a tool or a component. Finally the should be self describing allowing the user access to service details. Applications built around web services can range from very a very simple function provider to very complex collaborative systems that exploit secure reliable transaction based messaging, asynchronous behavior with read and update capabilities.

Standards and Frameworks

The presence of standards and industry frameworks are important drivers in the growth and widespread adoption of web services. The following is but a sampling of some of the more important standards and frameworks in use today.

- SOAP – (Simple Object Access Protocol) was designed as an open RPC protocol that utilizes XML and targets essentially the same problem domain as CORBA, DCOM, and Java RMI (distributed object/ interprocess communication). The big difference is that it is open source and developers find it easier to use. Because of this it has been adopted by the WWW Consortium as the preferred XML Protocol. In addition the .NET framework relies on SOAP as its RPC standard protocol. The SOAP specification is part of a group of WWW Consortium specs that include Web Service Definition Language (WSDL), Universal Description Definition and Integration (UDDII, and SOAP and is referred to as WUS.

  Web Services and applications built using SOAP range from very simple client server systems to more complex systems that exploit secure messaging, service descriptors, and services registry via the UDDI and WSDL.

- EbXML - Because of its self describing, and self defining nature all web services exploit XML in some fashion. ebXML is a suite of specification built on top of XML that can provide a host of capabilities such as secure reliable messaging, business process specification, and service registries and repositories, as a means for automating ad-hoc business collaborations. It was sponsored by the. United Nations Center for Trade Facilitation and Electronic Business (UN/CEFACT)

- NET – Microsoft's framework for distributed applications, web service based development, language and platform independence. The .NET framework includes the Common Language Runtime (CLR) which contains common class libraries providing a consistent foundation and set of APIs across all languages supported by the .NET framework

- J2EE – The Sun Java framework for enterprise apps includes all the necessary building blocks for service based architecture. In essence it is a standard set of Java API's which are the most relevant for building industrial strength enterprise applications. The J2EE approach is to wrap both Java and non Java web service components into newer components. In addition the cataloging of applications into design patterns, allows for faster and more efficient development.

GIS and Web Services

GIS on the Web

GIS applications deployed over the Web are quite commonplace today. Such utilitarian tools as direction finders which exploit basic GIS routing functions are extremely useful to the consumer. In addition many federal, state and local governmental groups are using the web as a cost effective way of publishing geographic data. Likewise private enterprises such as utilities have found that web enabled GIS applications are cost effective solutions as a means of extending the availability of their GIS investments. Most of the major GIS software vendors also offer web based APIs and product. Most of the major GIS vendors offer GIS web development platforms such as ESRI IMS (Internet Map Server and GENS SIAS (Smallworld Internet Application Server) that allow for the creation of GIS enabled web applications.

Rationale for GIS as a Service

Once we accept the paradigm of software as either a consumer or provider of a service, which is restating the premise that all software is essentially either a client or a server, then the relevant question is what types of applications lend themselves to this model. GIS and their related functions lend themselves quite nicely to this paradigm. Typically the GIS user is interested in obtaining a map or a location or driving directions, or any geographically referenced data value. We can see how these requests fit very nicely in the services development approach.

Location Based Services (LBS)

LBS are an excellent illustration of a very basic service with a universal appeal. Users would like to know either their location or that of an asset or entity. A location based service provides this basic functionality without the user of the service having to know the details of how the location was determined. The user of the LBS would in most cases be another application or service which inturns adds value and additional content by wrapping the LBS as part of another service. For instance a GIS service or application could provide additional content to the value derived from the LBS. For instance a simple query such as what will my travel time to my destination be. Or which service personnel is closest to a given service order could be implemented as a request to an LBS service from within a GIS functional service request from within the main application. This chaining or wrapping of services can all be seen as a ‘value chain’ where different providers can add their own value and content. It is estimated by the OGC consortium that the world wide market value of LBS related business is likely to approach $10 billion within the next few years. (OGC 2003)

Location Based Services (LBS) are a natural outgrowth of the merging of web services, wireless communications, and geospatial or GIS technology. LBS are of most value to users of mobile devices. So it is not surprising that various LBS methods/techniques exist. The following is a small sample.

1. A-GPS – Satellite based Geographic Positioning System (GPS) is used as the 'engine' that derives the units location. As the cost of GPS receivers continue to both drop in price and shrink in size. The option of having a GPS receiver within mobile devices is a cost effective solution.

2. TDOA - LBS servers that exploit cellular phones signal strength as it arrives to 3 or more transmission towers can triangulate a location using the TDOA (Time Difference On Arrival), typically this would be a service offered by the carrier.

LBS Standards

OGC OpenLS – The Open GIS Consortium (OGC) is an association committed to achieving interoperability in the GIS or Geospatial arena through the implementation of open standards. Initially their efforts were associated with achieving open GIS API's and data standards. The OpenLS initiative has as its goal to develop candidate interface specifications for interoperable LBS. It promises to deliver true interoperability in the area of LBS via the implementation of standard LBS services. The current framework consist of a reference architecture know as the GeoMobility Server which implements a series of LBS and GIS servers and which a user can easily adopt and incorporate in their own frameworks and applications.

The OpenLS GeoMobility Reference Server Architecture consists of the following:

1. Core Services – All the functionality is implemented as GIS web services. These services are the building blocks on which OpenLS compliant apps are built. The services are all geospatial in nature for instance the geocode service will return a location's street address. The gateway service returns a location for a networked device mobile or otherwise. The gateway service in turn utilizes the MPC, GMLC services. These are external location management services in the cellular wireless world MPC pertains to CDMA/TDMA while as GMLC pertains to GSM networks.

2. Abstract Data Types (ADTs) – Well defined information model that the various services operate on

3. Framework - The framework is open and extensible and utilizes an XML schema referred to as XLS , which is XML for LBS

Core Services	Abstract Data Types	Framework
▪Gateway Service	▪Route Summary	▪Open Architecture
▪Directory Service	▪Route Geometry	▪XML for LBS (XLS)
▪Route Service	▪Route Directions	▪ Interface Encoding Req
▪Geocode Service	▪Location	
▪Presentation Service	▪Position	

▪Location Service	▪Address ▪Map ▪Point of Interest ▪Area of Interest	

Table 3: OGC OpenLS Specification

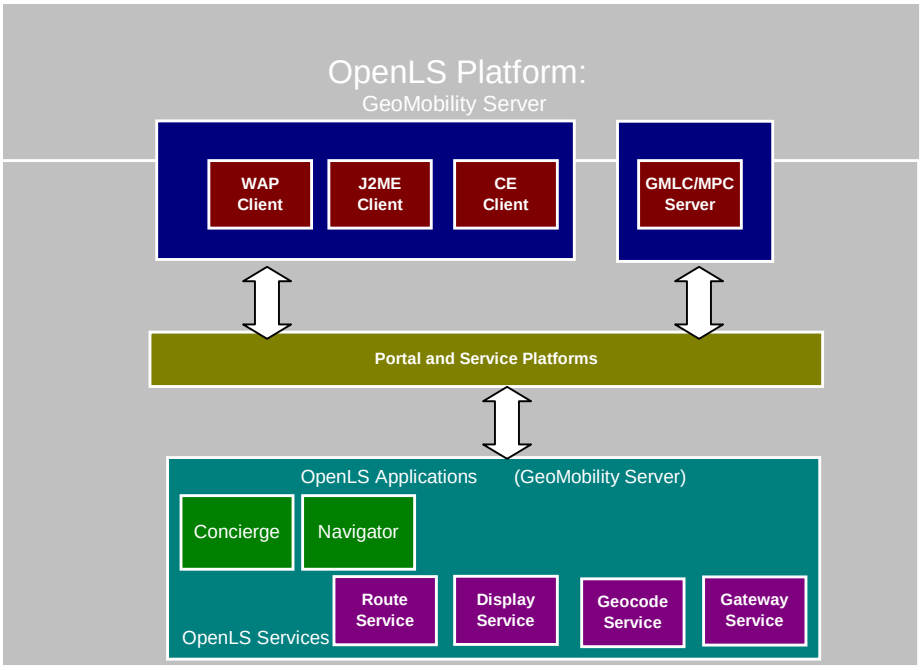

Figure 1: OpenLS Architecture (Niedzwiadek 2002)

LIF-MLP-Another competing standard is LIF-MLP (Location Interoperability Forum- Mobile Location Protocol) represents yet another approach toward interoperability. "While as OpenLS represents an architecture that attempts standardization at the higher levels data structures and presentation layer, LIF approaches location interoperability from the wireless network viewpoint, by introducing the Mobile Location Protocol (MLP) standard, which is concerned with the integration of position or location in the carrier communications environment, LIF has been able to focus its efforts on a single industry-wide capability to handle the location from either a Mobile Positioning Center (MPC) or Gateway Mobile Location Center (GMLC)." (VanderMeer 2002)

Implementation

A more concise implementation oriented definition of web services would be that they are designed to be lightweight, flexible, XML based middleware for integrating systems over the intranet of internet (Haulding and Sekar 2003) the following is an implementation checklist of the steps required in a typical web services implementation. This particular case study involves a heterogeneous integration of J2EE services and .NET clients.

Table 4: Implementation Checklist for Services (Haulding and Sekar 2003)

1	**Write the EJB using XDoclet**
2	Write the web-service interface and SOAP binding implementation classes
3	Compile web-services interface and supporting classes
4	Generate WSDL and WSDD deployment descriptor files
5	Generate EJB objects including Java classes and EJB deployment descriptors
6	Precompile all classes
7	Generate the EJB jar file
8	Create a single combined WSDD file from each of the service specific WSDD files
9	Create the WSR JAR file
10	Deploy EJB and WSR files to the JBoss server configuration
11	Run the Junit test scripts to verify correct server configuration
12	Develop the C# (.NET) client application

Applications

There are many possible applications of LBS. As wireless devices become commonplace and users and providers become aware of the synergy and value of location aware networked mobile devices. LBS applications will continue to become more common. The following is but a general survey of the most common applications.

1. Security /Emergency Response – Because of the location and communications aspects of LBS, many LBS applications would fall in this domain. The FCC E-911 initiative/directive, which requires that wireless carriers implement a location, enabled 911 call capabilities which is referred to as E-911 (enhanced 911), has generated a demand for interoperability in the LBS field. In addition the Homeland Security initiatives continue to drive new requirements for LBS and GIS in general.

2. Navigation (Telematics) – The estimates are that by 2006 80% of all new vehicles will have onboard navigation (eyeforauto 2001) the primary application is various forms of routing, route management, and roadside assistance.

3. Work Force Management and Logistics – Organizations and corporations are realizing the benefits of LBS through applications like work force management were personnel resources such as field crews must be optimally allocated. This invariably involves such factors as location and travel times which can be determined through the use of LBS and GIS services.

4. Tracking – Whether one is tracking trucks, people, or packages, tracking applications utilize LBS to determine location and time.

5. Wireless Network Management- LBS can assist in solving some problems that arise in the management of wireless networks such as seamless handoff as a networked mobile device crosses over from a cellular network into a WiFi network.

6. Location based marketing – service providers can add content thus providing such services as directory services where a user can look up business that are close to his location

GIS Web Services and Real-time Data

As we have seen, there is a tremendous utility to the coupling of GIS services with real-time location information. LBS that utilize GPS in their implementation can provide x, y, z coordinates as well as the time stamp when the measurements were derived. The wireless communications capabilities of mobile devices will provide this data in near real-time to the application servers, the true potential of GIS services however; becomes more apparent when other real-time data values are collected as well. GIS is an excellent tool for the reduction of multivariate geospatial data. The implementation of GIS functionality as a service allows us to deploy only the limited level of functionality necessary to meet the desired results. The following reviews several interesting applications.

- **SCADA, OMS, and GIS** – When SCADA, OMS and GIS are integrated it provides a synergistic blend. GIS provides the backdrop and data reduction against which OMS (Outage Management System) work. OMS predicts the most likely or probable location based on trouble call data and the customers spatial location on the electric network. If the OMS happens to be SCADA enabled, then a real-time interface to a SCADA system provides additional data concerning the actual state of the networked devices. (Schultz 2000)

- **Seismic monitoring** – The USGS is one of the foremost consumers of GIS technology as a tool for the advancement of earth sciences. One of the areas of emphasis has been in the monitoring of seismically active areas with telemetry particularly the utilization of seismometers and accelerometers and the integration and reduction of this real-time data with GIS. The USGS has also web enabled their GIS seismic monitoring applications so that they are available on the web. In

addition they are currently more elaborate applications where real-time data is received from the array of sensors, processed and integrated with their 3D subsurface basin models. Applications have also been developed that will page key personnel threshold seismic events in critical areas such as nuclear power plants are eminent, based on the geospatial analysis of real-time data

Conclusions

Web services and particularly GIS/LBS will continue to flourish as wireless communications and interoperability continue to move in the direction of location awareness. The end result will be a location aware infrastructure amplified and augmented with real time data. Consumers will be the beneficiaries of an ever growing array of services and data content as the 'value chain' providers scramble for market share. Organizations and corporations likewise will increase their effectiveness and efficiency with complex distributed applications that take full advantage of location and geospatial analysis as key components in mission critical applications.

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