April 2013 IJMIE Volume 3, Issue 4 ISSN: 2249-0558

GEOSPATIAL WEB SERVICE APPLICATIONS AND DEVELOPMENT IN NIGERIA

Christopher Ndehedehe*

Onuwa Okwuashi*

Simeon Ogunlade**

Otobong Udom***

ABSTRACT

Geospatial web services (GWS) help users find, access, and sometimes manipulate data of interest on the web dynamically from a distributed network. GWS are designed to collect data once and update or edit it in real time. Geospatial information system (GIS) software has enabled users to view spatial data in its proper format. As a result, the interpretation of spatial data has become easy and increasingly simple to understand. Unfortunately, everyone does not have access to GIS, nor would he be able to spend the time necessary to use it efficiently. WebGIS becomes a cheap and easy way of disseminating geospatial data and processing tools. Many organizations interested to distribute maps and processing tools without time and location restriction to users. Internet technology has made its way to many government organizations as well as numerous households. The ability to get information through the internet made spatial data providers to explore the internet resources for disseminating spatial information. This paper discusses the applications and development of geospatial web services in Nigeria. The paper also reviews the history, types, general concepts and an overview of enterprise geospatial web service design and development.

Keywords: Geospatial Web Service, Location Based Serviced, Enterprise GIS, Geospatial information system, Web Geospatial information system

* Department of Geoinformatics and Surveying, Faculty of Environmental Studies, University of Uyo, Uyo, Nigeria

** Department of Surveying and Geoinformatics, School of Environmental Technology, Federal University of Technology, Akure, Nigeria

*** Department of Surveying and Geoinformatics, Faculty of Engineering, University of Lagos, Lagos, Nigeria

1. INTRODUCTION

Internet allows all levels of society to access Geospatial Information, and provides a media for processing Geo-related information with no location restriction. Geospatial web services represent a natural answer to the growing requests for dissemination and use of geographical information data. Web Geospatial information system (WebGIS) originates from a combination of web technology and the Geographical Information System, which is a recognized technology that is mainly composed of data handling tools for storage, recovery, management and analysis of spatial data. Distributing Geospatial Information on the internet is an enforcing factor for information providers (Steiniger et al, 2006).

History shows that what we now know as mapping started as representation of geographic features on clay tablets. This has over time evolved into GIS with the advent of sophisticated computers. The first GIS was the Canada Geographic Information System, designed by Roger Tomlinson in the mid-1960s as a computerized natural resource inventory system. Almost at the same time, the U.S. Bureau of the Census developed the DIME (Dual Independent Map Encoding) system to provide digital records of all U.S. streets and support automatic referencing and aggregation of census records. It was only a matter of time before early GIS developers recognized the core role of the same basic organizing concepts for these superficially different applications, and GIS came to present a unifying focus for an ever wider range of application areas (Kemp, 2008). It would be noteworthy to mention that no single discipline can be credited with this evolution as what we now call GIS came through multiple parallel but separate applications across numerous disciplines (Pickles, 1999).

GIS has today found even more acceptability with the advent of Web-based mapping applications. The use of the Web as a dissemination medium for maps can be regarded as a major advancement in cartography and opens many new opportunities, such as real time maps, cheaper dissemination, more frequent and cheaper updates of data and software, personalised map content, distributed data sources and sharing of geographic information (Neumann, 2007). With the advent of the concept of the World Wide Web and the Web browser through research works by Tim Barners-Lee and others, the Internet has changed the way we do a lot of things. Several applications have leveraged on the World Wide Web with the fast Internet speeds of today to get more acceptability and patronage. This is exactly the case of Web-based mapping applications. Web maps can be classified as static or dynamic (Kraak, 2001). With recent advances in Web mapping technologies, this classification can be further expanded but we shall not be going into much details of this.

1.1 Geospatial Web Services by Type

The Geospatial web services (GWS) implementations, whether for geovisualizations, spatial analysis, mobile, or geogrid options, are being enhanced by collaborations with regional and global consortiums (e.g., Open Geospatial Consortium (OGC).

1.1.1 Web Map Services

Web Map Services **(**WMS) provide users with a means to serve georeferenced maps available from a GIS server over the web. Servers using the WMS 1.0 implementation produce a map, answer basic queries, and communicate their functionality to other programs through GetMap, GetFeatureInfo and GetCapabilities interfaces. Via the GetFeatureInfo interface, users can retrieve attribute info pertaining to a mapped feature. WMS are implemented in over 280 products. If users request maps with the same bounding box, spatial reference system, and output size, they may produce a composite map built from sources located across a distributed

WMS network. Where earth observations are requested, a WMS metadata model is required. When large or frequent map requests are made of a server, map caching may be slow. To work around the performance issue, pre-rendered images, or tiles, may be used (as in Google Maps) to speed the retrieval of WMS requests relating to Earth observation.

1.1.2 Web Coverage Services

Web Coverage Services (WCS) OGC's raster service standard, retrieves "coverages" or geospatial information pertaining to multidimensional phenomenon at points in space that vary across geographic region. Each WCS provides access to simple or "grid coverage" information via three operations: GetCapabilities, DescribeCoverage, and GetCoverage. The information (available data and metadata), although not displayed by WCS, may be portrayed by WMS, used in multi-valued coverages, or used in scientific models. Its functionality facilitates the subsetting, scaling, reprojection, and format encoding of grid data.

1.1.3 Web Coverage Processing Services

Web Coverage Processing Services (WCPS) is an extension of the WCS v. 1.1.2 and is based on the WCPS language interface standard (http://www.opengeospatial.org/standards/wcps).The protocol-independent language permits processing requests of "coverages" or multi-dimensional digital geospatial information that varies spatially and/or temporally. It enables the, extraction, processing, and analysis functions pertaining to the sensor, image and statistics data represented by coverages. It is thought to bridge WCS and WPS. Since WCS are limited to quadrilateral coverages, multi-dimensional data is available at the grid points. Interpolation may provide data between the grid points. Petascope (http://www.petascope.org) is the reference implementation of WCPS.

1.1.4 Web Feature Services

The Web Feature Services (WFS) interface permits users to access and manipulate geospatial feature information from distributed network sources. Basic operations include GetCapabilities, DescribeFeatureType and GetFeature operations. More complex operations are available through the WFS-T service interface described below.
The WFS interface permits users to access and manipulate geospatial feature information from distributed network sources. Basic operations include GetCapabilities, DescribeFeatureType and GetFeature operations. More complex operations are available through the WFS-T service interface described below.

1.1.5 Web Processing Services

Web Processing Services (WPS) seem to offer users an unlimited capability to build and facilitate the publication of geoprocessing tools for vector and raster data. Implementations may be considered middleware. Here processes pertain to calculations, algorithms or models involving georeferenced data. In publishing, binding information and metadata are made available to facilitate discovery and access. For interoperability, standards for application profiles for each process are offered. Users finding a WPS service may input data and execute the process without knowing about the interface or application profile. WPS provides for both platform-neutral and platform-specific specifications. WPS uses DescribeProcess and Execute operations for encoding requests and responses, embedding data and metadata, referencing inputs and outputs, and requesting storage of outputs. The construction of repeatable workflows

is possible with WPS through an orchestration of service chains, calling a sequence of web services, or via simple service chains.

1.1.6 OpenGIS Location Services (OpenLS)

OpenLS is an interface standard that consists of a set of basic and more complex services. The core services include a directory service, a gateway service, a location utility service (to geocode and reverse geocode), a presentation service, and a route service. The directory service helps subscribers access the nearest or specific place. The gateway service retrieves the location of a mobile terminal (device). More complex services include a navigation service and a tracking service. The navigation service is an enhanced route service and network accessible. The tracking service tracks a group of moving objects.

2. IMPLEMENTATION OF GEOSPATIAL WEB SERVICES IN NIGERIA

A Web Service is simply a software component that can be accessed across the World Wide Web (www) for use in other applications. Various governments across the globe, especially in developed countries, have successfully deployed location-intelligent applications for effective planning for sustainable development. This success has been hugely attributed to the fact that in every society, the government is usually at the fulcrum of sustainable development which in itself requires spatial considerations. The following attempts have been made in developing geospatial web services in Nigeria.

2.1 Abuja Geographic Information Systems (AGIS)

In 2003 the Federal Government embarked on a complete computerization of the cadastral and land registry of the federal capital territory (FCT) this led to the establishment of an agency known as Abuja Geographic Information Systems (AGIS). Within three years of its establishment the project was able to revolutionize the entire operations of the Land Administration and other land related departments of the FCT. Decision concerning land can now be taken from an informed position with a reliable and up to date data. The AGIS project includes the introduction of Spatial Data Infrastructure (SDI) for F.C.T., the computerization of spatially related workflows in selected FCDA departments and agencies and the build up of the AGIS Resource Centre. AGIS also is the new FCDA (Federal Capital Development Agency) department for computerized land administration.

2.2 Lagos State Enterprise GIS

The Lagos State Enterprise GIS (LAGIS) so far is one of the best webGIS developed for the management and administration of geospatial data within the region. The portal is very engaging and stimulating. It provides public access to the best of Lagos. The concept is world class and the implementation is brilliant. From a usability point of view, the layout and the map tools are very easy to use and refreshing. Lagos state is now listed among huge metropolitan hubs like New York, London, Canada, etc that have dedicated interactive online map portal. This portal has a complete list of relevant map tools that encourages serious exploration and exploitation of the map content. The Zoom tools are standard professional tools and very easy to use. The panning tool is delightful. Other tools like Identify, Previous Map, MapTip etc are very illuminating as they take map interaction to the next level.

A comparative analysis between the LAGIS portal and the Google map reveals that Google map content fades into insignificance when compared with what LAGIS portal has. The LAGIS map is of a better resolution than Google maps (see Figure 1: A and C below). Crisped boundaries of various wards in the interior can be displayed on the portal. It is obvious that here in Nigeria there is no public portal in the world that holds this level of details for Lagos. This therefore makes LAGIS the most advanced online map data in the world for Lagos.

Figure 1 Lagos State Enterprise GIS (figures A-C depict an Enterprise GIS application for Lagos State; figure D is the map of Lagos State)

2.3 Rivers State Government Web GIS Application

This WEBGIS application was developed by E-Sense Technologies Ltd Port Harcourt, for the Rivers State Government as part of the E-Service (see Figures 2 and 3).The project was a major first step towards the development of geospatial web services in Nigeria and an encouragement to other governments across the country to leverage on the potentials of low-cost web-based GIS applications for more stakeholder participation and effective governance. Specific attempts were made by the Rivers State government to use GIS in governance and narrowed down to the Web-based GIS application for the e-service portal (Sibe, 2009). An ordinary user, with a working knowledge of Web browsers, can now perform tasks hitherto restricted to the GIS user with sophisticated skills. This has ensured that more and more users become "spatially aware" and location sensitive.

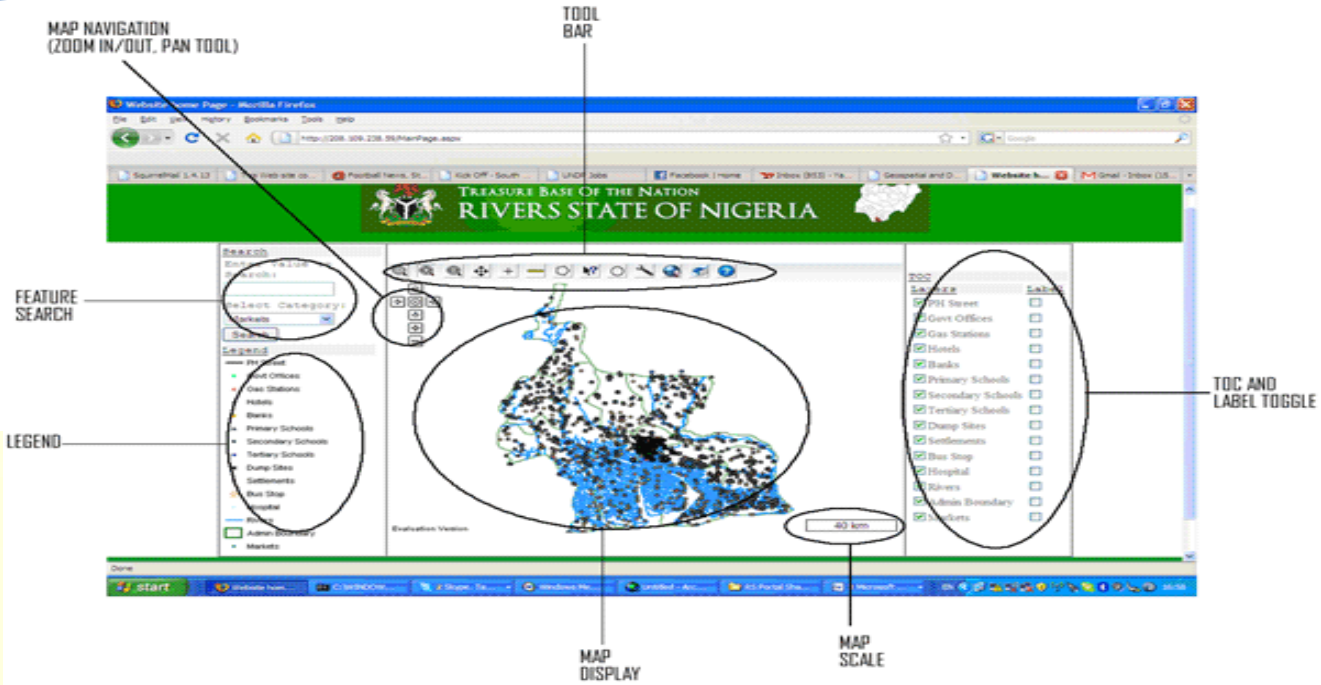

Figure 2 A WEBGIS application for Rivers State

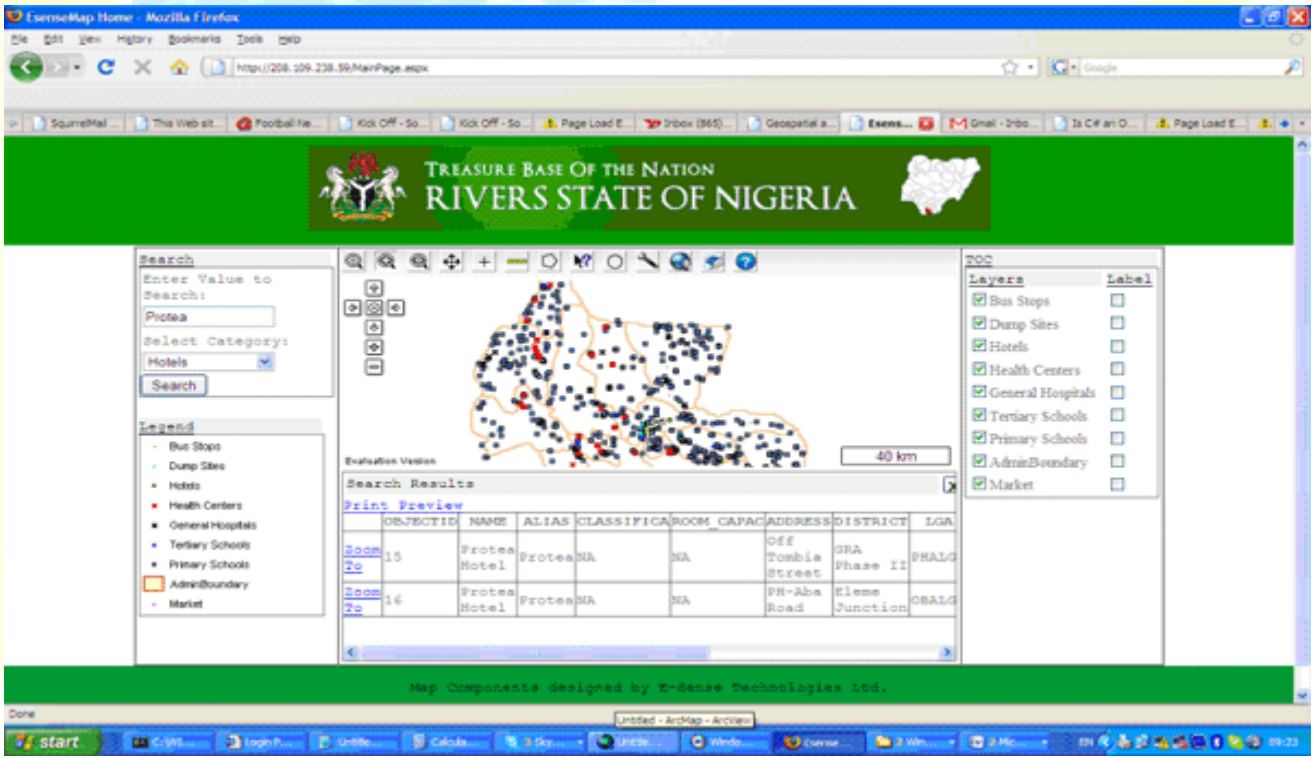

Figure 3 Screen capture of application showing results of search (in this case Protea Hotel in Rivers State)

2.4 Location Based Services in Nigeria- The Starcomms Approach

Location-based services denote services provided to mobile users according to their geographic locations (Beaubrun et al., 2007). Location based service are deployed in most parts of the world

by telecommunication companies such as AT & T and allows subscribers track the whereabouts of their friends, family members etc.
StarTrack, a new service which allows subscribers (Locators) on the Starcomms network in Nigeria to know where their friends, family, team and loved ones are via SMS at any given point in time, but only with the consent of the subscribers being located (Locatees).
With the aid of StarTrack, subscribers would be able to keep up with their buddies wherever they are – in school, at the club, the cinemas, in the mall or at their office and hook up with them. As the first telecommunications operator in the West African sub-region to commence this service, Starcomms has shown its strength as an innovative company.

2.4.1 How The Star Track Works

To use StarTrack, subscribers are required to register for the service by sending an SMS in the following format: REG & name to 33391, and then add friends via SMS in the following format: ADD & name & Starcomms number to 33392. When you request the location of a consenting person, you will receive an SMS with a written description of their recent location, including time and date.
To locate loved ones, subscribers can send in the following SMS: FIND & name or number to 33392. This service uses the mobile network locations of the cell sites. The subscriber's location would be indicated as the respective cell site location as in the vicinity of the cell site address with time & date of the Starcomms phone radiating last when the query was sent.
Subscribers can also request for the complete list of those that can be tracked by sending SMS: LIST to 33392 while the list of those that can locate a subscriber can be requested for by SMS WHO to 33393.

2.5 Overview of Enterprise GIS Design and Development

Successful implementations of GIS technology all have a few things in common. They have support from executive leadership, they have experienced and properly trained staff, and they have an organizational structure that works collaboratively to define the GIS vision and carry it out (Longley, et al, 2000). In Developing an enterprise GIS (EGIS) there is need for an implementation plan to guide the development of the enterprise GIS. Municipal EGIS implementation plans divide the implementation process into three phases. The three phases build upon one another, with each phase providing clear benefits. The deliverables from each phase not only document the results of that phase but also serve to further define the work in the subsequent phase.

Phase 1—EGIS Needs Assessment and Concept Definition: This phase addresses business process definition, system and data requirements definition, conceptual system design, and implementation strategy preparation.

Phase 2—Detailed Requirements Definition and System Design: This phase addresses the detailed requirements and design for enterprise components as well as departmental systems within the context of the enterprise requirements. Detailed business process engineering, coupled with detailed database design and system specification, is completed for the business critical applications. Often applications to support widespread visualization of data resources are emphasized to demonstrate high return on investment.
Phase 3—System Implementation: This phase addresses the implementation of enterprise components and departmental components in compliance with established enterprise GIS governance standards and protocols. Business critical applications and database resources are

developed, along with the system infrastructure, to ingest, manage, and deliver the GIS data, products, and services.

3. GEOSPATIAL WEB SERVICES: A RESEARCH PRIORITY

With the incredibly rapid proliferation of web applications, Internet commerce, wireless communication, and small electronic devices, it will be important to investigate how to further improve the integration of geospatial analytical functionality with these technologies.

3.1 Significant Research Questions

How should data models and data structures for web and mobile GIS differ from conventional GIS data structures? What would the data model of a web site or a multi-user domain (MUD) such as a chat room be? New data structures for web GIS need to be developed to accurately represent movements across networks, file permissions, legacy files and data sets, teleportation, etc. Are there standard metrics for GIS functionality that should be developed for specific application domains? What are the appropriate measures of performance for web and mobile GIS? What are the primary barriers to the usability of most web GIS sites or to mobile mapping devices? Usability engineering techniques should be investigated and deployed. An example would be the development of multi-level Web-to-database interfaces for web GIS, to enable the customized access to meet the needs of very different user groups. To what extent does a web map or a specialization accurately reflect the data? What are the ethics of web GIS and access to geographic information on small electronic devices such as cellular phones, PDAs, or pocket PCs? To what end should pervasive computing technologies be developed? Web technologies, for example, are normally best used with broadband access in order to get satisfactory results. And yet, according to McGovern (2001), who cited statistics from NetValue, only 11% of American, 5% of German, 4% of French, and 3% of British households had such access in 2001. And within these privileged households, how do people really use or respond to ever increasing amounts of geographic information?

4. CONCLUSION

A Web Service is simply a software component that can be accessed across the World Wide Web (www) for use in other applications. Geospatial Web services offer real potential for meeting the demands of a more encompassing, wider Societal GIS vision that will bring significant and lasting benefits to the way information flows through society.

Geospatial-web services are location based and provide a media for processing Geo-related information with no location restriction. With the development of Web-GIS, the Internet is now becoming a portal for GIS functionality as well as data distribution.

With the incredibly rapid proliferation of web applications, Internet commerce, wireless communication, and small electronic devices, it will be important to investigate how to further improve the integration of geospatial analytical functionality with these technologies.

REFERENCES

Beaubrun, et al (2007). An Architecture for Delivering Location-Based Services, International Journal of Computer Science and Network, VOL.7 No.7, Québec, Canada.

Helali et al (2002). WebGIS Technology and its Applications, paper presented in Symposium on Geospatial Theory, Processing and Applications, Ottawa.

Implementing Geospatial Web Services (2012). A Resource Webliography in http://www.opengeospatial.org/standards/wcps ,(http://www.petascope.org).

Kemp, K. (2008). Encyclopedia Of Geographic Information Science, page 188 SAGE Publications Ltd.United Kingdom.

Kraak, M. J. (2001). Settings and needs for web cartography, in: Kraak and Allan Brown (eds), Web Cartography, Francis and Taylor, New York, p. 3–4.

Lamm, S.E. and Vick, D.A. (2005). Wide web traffic, university of Illinois, in M. Dodge's Atlas of Cyberspace, www.cybergeography.org/atlas/geographic.html http://proceedings.esri.com/library/userconf/proc01/professional/papers/pap1039/p1039.htm.

Longley, P. A., Goodchild, M. F., MacGuire, D. J., and Rhind, D. W. (2000). Geographical Information Systems: Principles, Techniques, Applications, and Management (2nd ed.). New York: John Wiley and Sons

Neumann, A. (2007): Encyclopedia of GIS, Springer ,page 1262, Hawaii.

Pickles, J. (1999). Arguments, Debates, and Dialogues: the GIS-social Theory Debate and the Concern for Alternatives. In P. A.

Sibe, R.T. (2009), Challenges of Mapping Applications in Health and Academic Research in the Underdeveloped World - Case Study of The Niger Delta Region (Nigeria) [Online]. Available at http://www.gisdevelopment.net/application/health/overview/Challenges-of-Mapping-Applications-in-Health-and-Academic-Research-in-the-underdeveloped-World.htm (Accessed 1st May, 2010.

Stefan Steiniger, (2006). Foundations of Location Based Services, University of Zurich.