Service Oriented Architecture Based SDI Model for Education Sector in India

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Abstract. Technological and overall economic growth of any country warrants a rapid development of the education sector, which is responsible for producing quality human resources for serving the nation and the human society as a whole. Hence, there is a need to make coordinated efforts to disseminate information about the quality of academic details in a simple but detailed manner by integrating modern technologies. Spatial technologies such as GIS, remote sensing and GPS hold potential to remove some of the bottlenecks that hinder the efficiency of this sector. Further, for Right To Education (RTE) easy to use/ perceive spatial information is required for the decision makers. Hence, there is a need to establish a well organised Spatial Data Infrastructure (SDI) portal where each stakeholder can access, use and exchange spatial information for education sector. The present work reports the development of an efficient interoperable Service Oriented Architecture (SOA) based SDI Model for education sector. The developed SDI Model is distributed, modular and allows the publishing of web service descriptions as well as to submit requests to discover the web service of user's interests. The Model supports integration of applications and browsers independent Web Map Service (WMS), Web Features Service (WFS), Web Coverage Service (WCS) and Web Catalogue Service (CS-W) for sharing and exchange of geospatial data.

1 Introduction

The accelerated growth rate of the economy and technology of any country warrants a rapid development of the education sector on which most of the quality human resources produce for servicing the nation. Human resources is an important component for economic and technological growth which contributes significantly to the economy of India. For producing quality human resources, academic sectors play a vital role, which is facing an increased competition on account of globalisation and the level of technology employed thereby necessitating new initiatives for meeting the new challenges. There is a need to make coordinated efforts to encourage people to get better information about the quality of academic details in greater way by integrating modern technologies. GIS, remote sensing and GPS are the technologies which may be used to remove some of the bottlenecks that hinder the productivity and efficiency of this sector.

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GIS is a system of computer hardware and software that enables users to store, manage, manipulate, analyse and retrieve large volumes of spatially referenced data and associated attributes collected from a variety of sources [7]. They may be used to create and maintain geographic database and are suited for analysis in planning related activities. The GIS has wider applications in decision making, storage of various kinds of data, bringing data and maps to a common scale for user need, superimposing, querying and analysing the large amount of data and designing and presenting final maps and reports to administrator and planner[12]. GIS can deal with large amount of spatial data at different scales as well as non-spatial data for deriving useful information in maps/ tabular from for better understanding for organised development. The utility and application of GIS for planning of land resources and decision making has become widely popular and are being used for a wide range of applications.

With the integration of web technology with GIS, it gives rich functionality in terms of spatial data sharing on the web. It can provide a real time and dynamic way to represent information through maps on web. So there is a need to establish a well organised Spatial Data Infrastructure (SDI) which is a portal where each stakeholder can access, use and exchange spatial data for social, economic and environmental application. Geospatial Web Service is one of the key technology require for development and implementation of SDI. Design and implementation of SDI is used service oriented architecture (SOA) which it is used for sharing academic detailed information on web. It enables the people to quickly look into the problem and gets the information according to their need.

Fortunately, there are many open source software that can compete the proprietary software in the field of GIS [10]. Developers have created several open source libraries and GIS suites to cope with the flood of GIS data and their formats [8]. The goal of Open Geospatial Consortium (OGC) is to encourage the use of open source GIS standards and development of community-led projects. The available open source GIS software can be used for the works related to database creation, spatial modelling and geospatial web based services [1]. The open source GIS software used for development of SDI include Quantum GIS for creation of geospatial database, MYSQL for storing of security aspects and non-spatial data, ALOV, GeoServer and Apache Tomcat for imparting geospatial web capabilities and PHP: Hypertext Preprocessor, JSP: Java Server Pages and GeoExt: Geo Extension for dynamic server side scripting.

2 SOA Based SDI

SDI provides an environment within which organisations interact with technologies to foster activities for using, managing and producing geographic data. It is the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain and preserve spatial data [13]. The core components of SDI can be viewed as policy, networking, standards, people and data. These can be grouped into different categories based on the nature of their interactions within the SDI Model [6][11].

Thus, an integrated SDI cannot be thought as having spatial data, value-added services and end-users alone, but instead involves other important issues regarding interoperability, policies and networks also. The development of SDI supports these decision-making functions at different administrative and political levels. The development of SDI at national level in India, i.e., Indian NSDI was initiated in 2000 jointly by Department of Science and Technology (DST) and Indian Space Research Organisation (ISRO) through the establishment of a national task force to prepare an action plan under the aegis of DST. SDI is a web based system developed under GIS environment. Thus, geospatial web service is an integral and important part of any SDI. The basic concept for geospatial data visualisation refers to web mapping of spatial data from various organisation and servers across the World Wide Web (WWW) by following the standards of W3C (World Wide Web Consortium) and OGC (Open Geospatial Consortium) [9].

OGC has defined various standards which are based on a generalised architecture captured, describes a basic data model for geographic features to be represented for web mapping. These standards have been developed to serve specific needs for interoperable location and geospatial technology, including GIS. Web Map Service (WMS), Web Features Service (WFS), Web Coverage Service (WCS) and Web Catalogue Service (CS-W) are the important OGC standards which are frequently used in many applications. Mapping on the Web includes the presentation of general purpose maps to display locations and geographic backdrops, as well as more sophisticated interactive and customisable mapping tools.

The Service Oriented Architecture tries to construct a distributed, dynamic, flexible, and re-configurable service system over Internet that can meet information and service requirements for development of SDI. The key component in the SOA based SDI is geospatial web service i.e. a well defined set of actions. It is self contained, stateless, and does not depend on the state of other services [15].

A geospatial web service is an application that can retrieve data from GIS databases and provide geographic information through a browser interface to end-users [2]. Thus, geospatial web capabilities indicate to a web based GIS which can be modelled using the client-server architecture. A thin client model is where most of the processing work is done on demand in the server and the client does not perform any task other than to display the data on screen.

In development of SDI Model, the major focus has been on SOA based geospatial web service by using spatial data. According to services, it can be grouped data service, processing service and catalog service [4]. Data service is tightly coupled with specific data sets and offers WFS, WMS and WCS. Processing Service provides operations for processing or transforming data in a manner determined by user-specific parameters. CS-W allows users and applications to classify, register, describe, search, maintain, and access information about Web Services [3].

The basic operations in SOA based SDI Model include publish, find and bind. To be able to integrate any services into SOA based architecture, it should provide at least one of the SOA's major operations. Figure 1 shows three major functionalities in SOA based SDI.

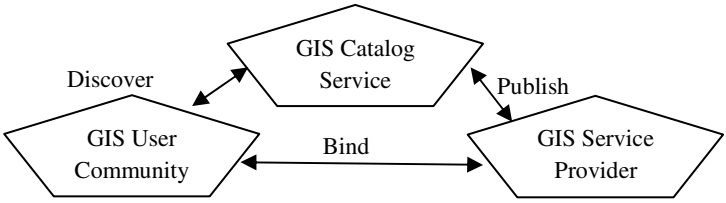

Fig. 1. Three major functionalities in SOA [14]

In SOA based SDI Model, there are three types of key actors i.e. service requester or GIS user community, GIS service provider and GIS catalog service. Catalog service can be called registry service or broker but their main functionality is almost same in most of the applications. Catalog service helps the requestors to discover or find the right services. When a service provider sets up a service over the internet and wants the users to use their service, it needs to publish their services. When a requestor requests a service, the requestors and service brokers need to collaborate to find the right services. After the right service is found, requestor and provider bind or negotiate as to format of the request. Then, the requestor can access and invoke services of the provider.

3 Objective of the Present Work

The main aim of the present work is to development and implementation of SOA based SDI Model. It is proposed to use Quantum GIS for creation of geospatial database, PostGIS and MYSQL for storing of spatial and non-spatial data, ALOV, GeoServer, GeoNetwork, GeoWebCache, WAMP and Apache Tomcat for imparting geospatial web capabilities in terms of WMS, WFS, WCS and CS-W. PHP: Hypertext Preprocessor, JSP: Java Server pages and GeoExt: Geo Extension are used for dynamic server side scripting for development of SDI Model.

4 Methodology Adopted

For development of SDI Model, the main focus has been on the use of a practical approach to explore and extend the concept of SDI in education sector. The developed SDI Model should provide an effective and efficient means of sharing geospatial data and non-spatial data on the web using GIS in a secure way. The proposed SOA based SDI Model in which it follows the basic over view of service provider, service consumer and catalog service.

In SDI Model, it focuses on OGC compliant web services on vector and raster data. Admin is managing the data and gives authority to the different user and Catalog is updated by catalog admin. In catalog, various services are published and ready for service requester i.e. web client and web client discovers the required service. Finally, The required services consumed by the service consumer. This architecture can be fulfilling the most sophisticated workflow for development of SDI Model. Figure 2 shows the layered architectural view that comprises of open source resources.

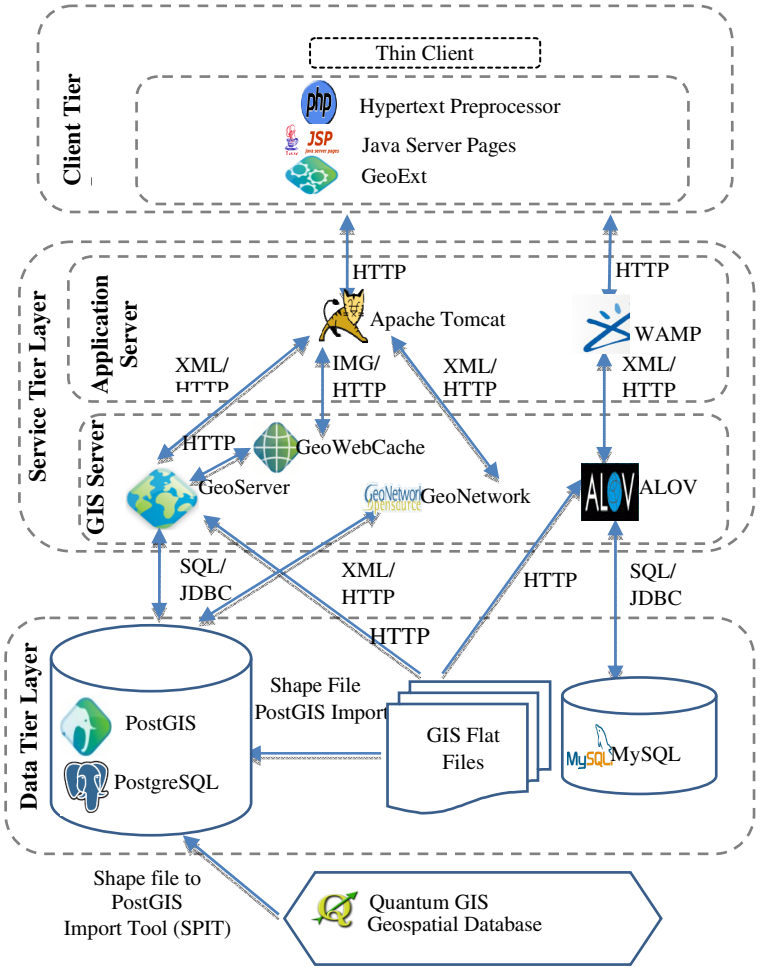

Fig. 2. Layered Architectural view of open source resources

For the creation of integrated geospatial database, the present SDI Model uses Quantum GIS open source GIS software. ALOV, GeoServer, GeoNetwork, GeoWebCache, WAMP and Apache Tomcat have been integrated for imparting the geospatial web capabilities with respect to WMS, WFS and CS-W services. PostGIS and MYSQL are used for storing of spatial and non-spatial data for decision making. PHP: Hypertext Pre-processor, JSP: Java Server Pages and GeoExt: GeoExtension languages have been used for dynamic server side scripting in the framework. In the present work, WAMP and Apache tomcat servers have been taken and then PHP, JSP and GeoExt scripting languages are used for sharing of the geospatial data and non-spatial data and for publication of maps on the web.

The National Institute of Technology (NITs) Network geospatial database and Motilal Nehru NIT geospatial database have been selected to demonstrate the

capabilities of developed framework. In the first slave server, the geospatial data and non-spatial data of the old and new National Institute of Technology (NITs) Network geospatial database is stored and in another slave server, the geospatial data and non-spatial data of Motilal Nehru NIT geospatial database is stored. From the master server, by using the scripting language, the geospatial data and non-spatial data of different geospatial database is easily accessed simultaneously.

5 Prototype Development

The prototype development is based on Jacobson's method of Object Oriented Software Engineering (OOSE) for incorporating strong user focus and the time critical nature [5]. The OOSE method involves the formation of models that capture the actors of the system and their behaviour for each of the design stages. The models are made up of objects representing real world entities. This is a natural way for people to describe their environment; and helps in reducing the semantic gap between the developed model and the real world. Figure 3 shows the complete process model for development of SDI.

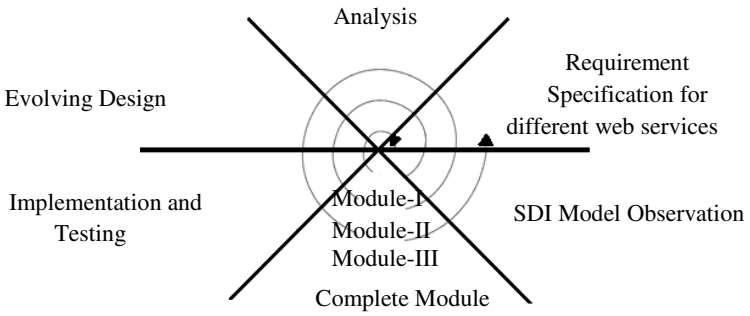

Fig. 3. Process Model for SDI

The process model of SDI is cyclic or incremental in nature and each implementation refines the analysis and design stages through evaluation and testing of a completed module. In Module I, NIT Network geospatial database has been prepared by Quantum GIS Open Source GIS software with the help of political map of India. There are three thematic layers has been created, in which one layer shows the complete India boundary and states boundary and second layer shows the individual state boundary including the location of NIT, and another layer gives the information of particular NIT. Non-spatial database or attribute database contents the information about National Institutes of Technology of India. In the first layer, it has linked with non-spatial data in form of table with ID Code and NIT State name as attributes. In the second layer, it has also linked with non-spatial data in form of table with the attributes as ID Code, NIT State Name and NIT Name. In the third layer, it has non-spatial data in table form with ID Code, NIT Name, NIT Rank, NIT State

Name, NIT Hyperlink, NIT Director Name, NIT Address and NIT Contact No as attributes.

The Module II defines the catalogue services by using Geoserver in which it registers all the desire services. Module III describes the integration of all the services provided by service provider. Initially, for development of SDI Model, it is defined by state diagram for better understanding of the system.

The Quantum GIS, ALOV, GeoServer, Apache Tomcat, MYSQL, PHP and Java Development Tool Kit are used for overall development of the system. Figure 4 shows all the old and new NITs in India.

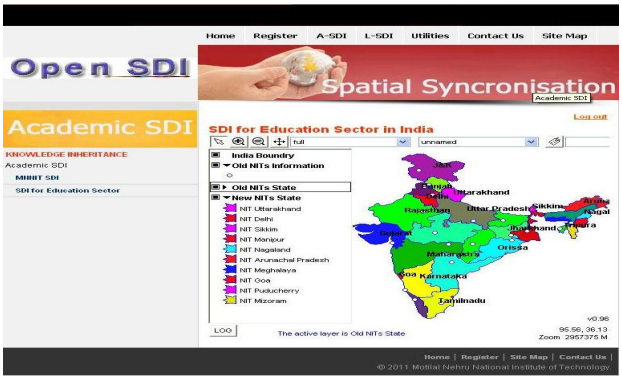

Fig. 4. Old and New NITs in India

6 Concluding Remarks

The present research work is focused at adopting SOA based architecture and OGC standards for creating, accessing, integrating and sharing the geospatial information on the web in education sector. The experience in using Open Source GIS software suggests that various tools and software like Quantum GIS, ALOV, GeoServer, GeoNetwork, GeoWebCache, Apache Tomcat, WAMP, MYSQL, PostGIS &, GeoExt and PHP are available for creation of spatial datasets and implementation of geospatial web services. The widespread use of these open resources in the development of GIS based applications on the web could benefit a vast user community instead of going for costly proprietary solutions and should be encouraged.

The main focus of the present work is to develop and implement open source GIS for SOA based SDI Model. Therefore, the database used for both NIT Network geospatial database and Motilal Nehru NIT geospatial database are indicative and does not contain detailed features. This database may be made more comprehensive in future studies. At present, SDI Model is operational at MNNIT intranet level only. The same may be implemented on the web in future studies.

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