Open Source Software Solutions in Geoinformatics – Implications for Greater Mekong Sub-Region

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Abstract

Over the last decade, Open Source Software (OSS) has grown tremendously in scope and popularity. OSS has gained the attention of the Geoinformatics community and created new opportunities for implementing Spatial Data Infrastructures (SDI). There are already several Geoinformatics related OSS packages available that could be tailored to suite the needs of the Greater Mekong Sub-region. In this paper, we present a prototype system that was developed by integrating the OSS GRASS GIS and PostgreSQL Object-Relational database into a Web based client/server environment. The prototype system can facilitate easy and rapid collection and dissemination of spatial information. Since the system is independent of any proprietary software, it is easy implement in a distributed spatial database environment at low overall cost. The system can serve as a platform for rapid implementation of spatial databases through collective participation and also serve as a means for standardizing data collection. We also present our ongoing efforts to improve the interoperability and facilitate compliance to international standards. Our experience shows that OSS is ideally suited for nations in the GMS and has potential to support Geoinformatics capacity building in the region. Further, adoption of OSS could stimulate indigenous software enterprises, and thereby enriching input to the global software community.

Keywords: Open Source Software, Spatial Database, Geoinformatics, GIS

Introduction

Geoinformatics technologies offer means to manage and collate spatial information on natural resources, environment and human habitat and servers as a useful tool for national development planning, resource management, disaster management and environmental monitoring. Geoinformatics technologies for managing and delivering geo-referenced information over computer networks could provide the much-needed conduit to transfer the benefits of these technologies to a wider audience. Many of the Geoinformatics technologies are now fully operational. It is ready to be put to use and has the potential to be an indispensable technology particularly in the Greater Mekong Sub-region (GMS) where spatial information is needed to support self-sustainable developmental activities. Most countries in GMS are faced by technical and cost constraints with regard to the development and implementation of Geoinformatics technologies. In particular, the cost of commercial software is too high for the less-well endowed countries in GMS to be able to build and maintain self-reliant, sustainable digital infrastructure for Geoinformatics.

Over the last decade, OSS has grown tremendously in scope and popularity. OSS has gained the attention of the Geoinformatics community and created new opportunities for implementing SDI. There are already several OSS packages available that could be tailored to develop spatial databases. In the present paper, we present a prototype system that was developed by integrating the OSS GRASS GIS and PostgreSQL Object-Relational database into a Web based client/server environment. We also present our ongoing efforts to improve the interoperability and facilitate compliance to international standards.

Open Source and Free Software

OSS (www.opensource.org) and free software (www.gnu.org) initiatives have become increasingly popular and dynamic over the past decade. They protect intellectual property through copyright, yet foster sharing, distributed development, bug-fixing, training, support, customization, etc. Detail descriptions of requirements for software products to qualify, as open-source "or" free software are available at the abovementioned websites. While some people try to differentiate between "free software" and "open-source" software, OSS in this paper refers primarily to software whose source code is openly accessible, whose ownership may be copyright but which includes collaborative development and/or adoption. OSS has the potential to be major contributor to capacity building in Asian region, especially for GMS countries. In the area of Geoinformatics, several OSS tools are available (Table 1) that could be readily used. OSS has the potential to provide Geoinformatics technology at cost levels that are affordable to organizations with limited financial resources. Prudent integration of OSS tools would enable the implementation of scalable and distributed spatial database systems to support SDI initiatives.

Table 1: Some Geoinformatics related OSS projects

OSS Project	Geoinformation Service
GRASS	GIS
OSSIM	Image Processing
MapServer	Web Mapping
GRASSLinks	Web GIS
GDAL	Data translation
PostGIS	RDBMS-GIS Interface
Geotrans	Coordinate transformation
PROJ4	Coordinate transformation
Metadata Clearinghouse	Isite
Djvu	e-document

Prototype System

The basic framework of the system is shown in Fig. 1. An online demonstration of the basic features is available at http://gisws.media.osaka-cu.ac.jp/slink/. "Spatial Query" option allows the user to retrieve attribute data from the RDBMS table by selecting a location on the raster image displayed on the web browser. The user selects the GRASS data layers from an interactive menu based on which the GRASS raster layer is displayed on the web-browser. The user can also select vector maps and site data as overlays for raster map layer (Figure 2). Interactive zoom/pan capability allows the user to view the displayed maps in greater details or to choose different areas for display. Once the desired area is displayed on the web-browser, the user is allowed to view the attribute table by "clicking" on respective site. The relational database is queried based on the geographical location (Figure 3a) of the "clicked" site. Attribute data is displayed in two stages. Firstly, a brief summary (Figure 3b) of the attribute information is presented. The summary table also includes a hypertext link, which can be followed to view more detailed information including figures and field photographs is also provided (Figure 4).

"Database Search" option allows the user to retrieve attribute information by keyword searching (Figure 5a). Search fields include name, location and date. In addition full-text searching is also provided. The results of the text based searching are the same as those shown in Figure 3b and Figure 4.

"Database Administration" option allows registered user to insert new attribute information into the RDBMS table. User can select the option (Figure 5b) to upload data by clicking a location on the basemap or directly input the location coordinates into the data upload form (Figure 6). This module also allows direct uploading of binary files such as images, sketches etc. from the client's computer to the database server.

The prototype system described above facilitates easy and rapid collection and dissemination of spatial information. Since the system is independent of any proprietary software, it is easily incorporated in a distributed spatial database environment at low overall cost. The system can serve as a platform for rapid implementation of spatial data infrastructures through collective participation and also provide means for standardizing data collection.

Interoperability and Standardization

Apparently, one of the main limitations of the present system is the interoperability and non-compliance with widely accepted international standards. In using the system described above, access to spatial data requires the information to be stored in the GRASS GIS format and the GRASS GIS needs to be installed on the server in order to get the system running. The advantage in having a full-fledged backend GIS running on the server would be the ability to implement online systems with spatial analytical capabilities rather than providing visualization or portrayal capabilities alone (as are commonly available in other Web GIS applications). Such online systems for 3D online geological modeling have been demonstrated in our earlier research (Raghavan *et al.*, 2000).

However, in most general situation of providing seamless access to spatial data, the advantages of adopting approach wherein issues such as interoperability and compliance to international standards far outweigh any other consideration. The OpenGIS Consortium (OGC) in cooperation with GIS experts and leading software vendors has evolved standards for spatial data and related information technologies. Specifications have emerged within the OGC for the design of interoperable systems for spatial data sharing amongst users with only map reading skills.

OSS MapServer project (http://mapserver.gis.umn.edu/) affords the development and deployment of OGC compliant Web Map Service (WMS). MapServer provides a cross-platform development environment for building spatially enabled Internet applications. Fig. 6 shows the various programming tools available for development of MapServer based applications. MapServer relies on numerous other OSS tools to convert vector to raster, draw true-type fonts, or create images. In addition to the built-in support for several spatial data formats, the MapServer can also be coupled with the Open Source GDAL (Geospatial Data Abstraction Library; http://www.remotesensing.org/ gdal/) that functions as a translator library for raster spatial data formats. As a library, GDAL presents a single abstract data model to the calling application for all supported formats (Figure 7). The related OGR Simple Features Library (http://gdal.velocet.ca/ projects/ opengis/) provides read (and sometimes write) access to a variety of vector file formats. Integration with PROJ4 (Eveden, 1990; http://www.remotesensing. org/proj4) enables support for over 120 different map projections. Software to transform raster, vector and site data between differently projected locations is also available.

Considering the obvious advantages of providing standardized data access and portrayal services, we are now in the process of enhancing the features of the present the spatial database system using the MapServer toolkit. In this regard, we have developed several applications using existing spatial data that are available through regional initiatives (e.g. DCGM III Working Group, 2001). Some example of the MapServer implementation using the data from Phuket, Thailand (Fig. 8a) and Hanoi City, Vietnam (Fig. 8b) have already been developed. Ongoing development is focused on integration an RDBMS interface to support better management of attribute information including multi-media contents.

Conclusions

The prototype system described in this presentation affords easy and rapid collection and dissemination of spatial information. Since system has been developed using OSS, it is easily adapted in a distributed database environment. The system provides the basic components for generation and delivery of spatial information at very affordable costs and would be greatly beneficial to small organizations that might neither have the financial resources nor range of expertise needed to implement proprietary solutions. The system would be useful in developing spatial databases through collective participation and could also serve as a means for standardizing spatial data collection. Such efforts will help coordinate better strategies for environmental assessments, hazard mitigation and resource evaluation. The ongoing work is focused improving interoperability, achieving compliance with international standards and integrating advanced RDBMS and multi-media capabilities. With these added functionality, the system could not only afford an efficient mechanism for the generation and delivery value-added spatial information but also serve as a tools to analyze spatial data that are being made available through regional initiatives.

Our experience in using OSS suggests that many basic tools for Geoinformatics are already available while others are undergoing rapid development. Existing OSS projects have the potential to provide necessary information and communication technology services. Widespread use of OSS would not only stimulate further developments of OSS projects but could also incubate/nourish indigenous Geoinformatics capabilities.

In the context of the GMS, OSS has the potential to offer locally developed and adapted solutions and thereby increasing choices for consumers, government and enterprises and reducing dependence on a particular vendor. Commercially packaged software are not always adapted or customized for local conditions except in the case of large and profitable markets. In order to promote the utilization of Geoinformatics technologies in GMS, it is imperative to foster national capacities in Geoinformatics and encourage domestic capacity building in software development and support services. Successful implementation of SDI depends on availability of trained manpower and experienced personnel. In addition, suitable software tools that are aptly customized and localized to the meet the area-specific needs must also be made available to the local application users. Since OSS is more amenable to customization and localization, its use could speed up the availability of spatial data and human resources within the GMS would help overcome major obstacles in implementing spatial data infrastructures in the region. Further, the appropriate utilization OSS in Geoinformatics could play a significant role in planning a sustainable development model for the region.

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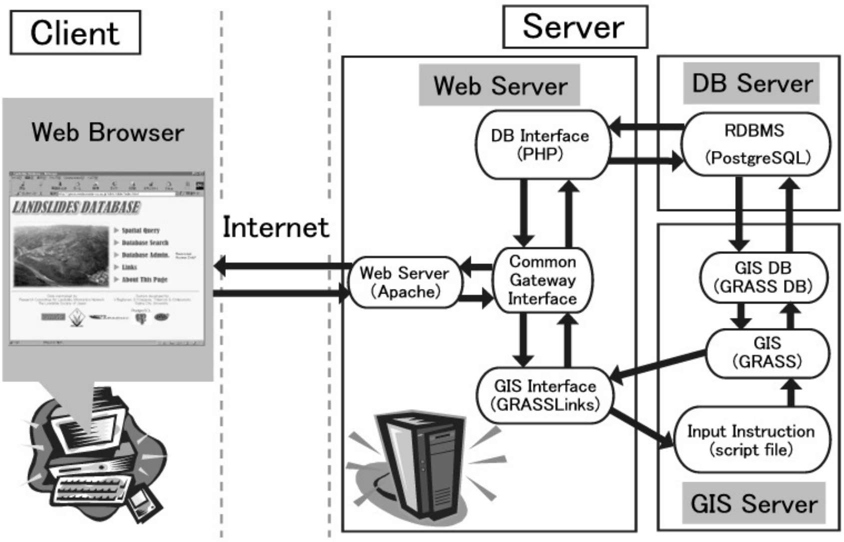

Figure 1: Components and Information Flow within the Prototype System

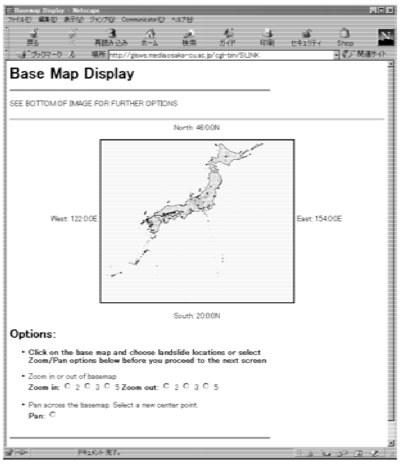

Figure 2: Query basemap

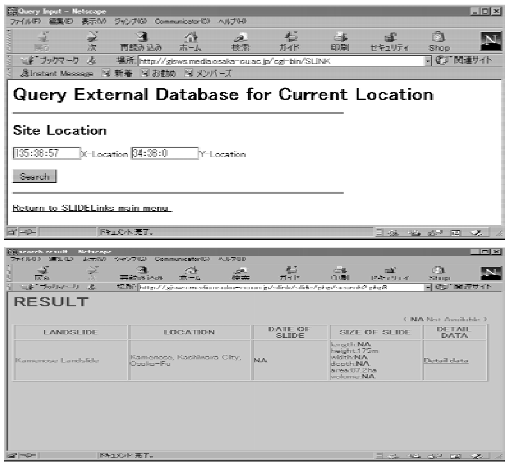

Figure 3: (a-Top) Location data (b) Query results.

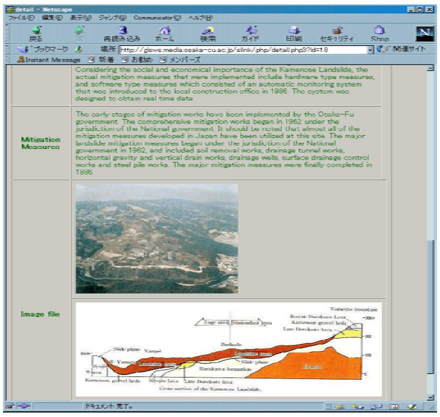

Figure 4: Attribute information.

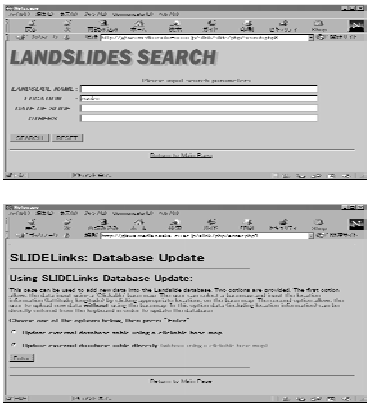

Figure 5: (a-Top) Keyword Search (b) Data Upload.

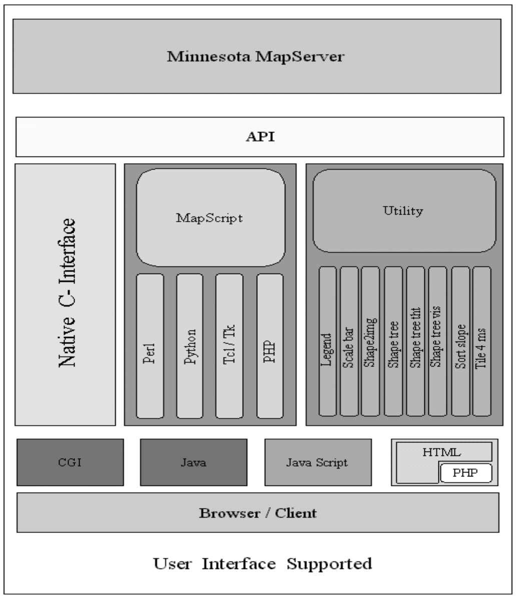

Figure 6: MapServer development tools.

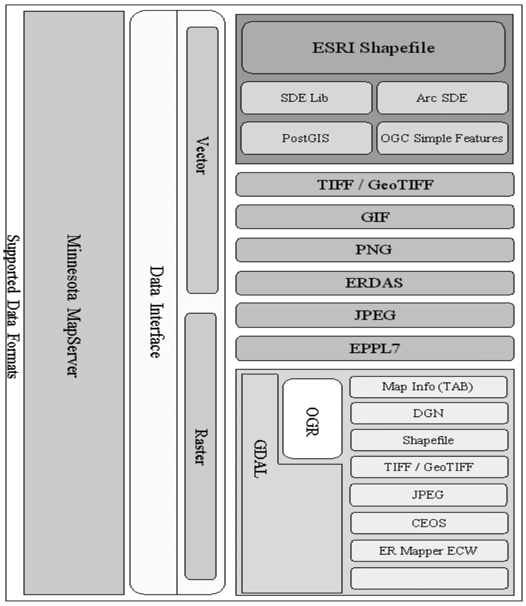

Figure 7: Data format supported in MapServer.

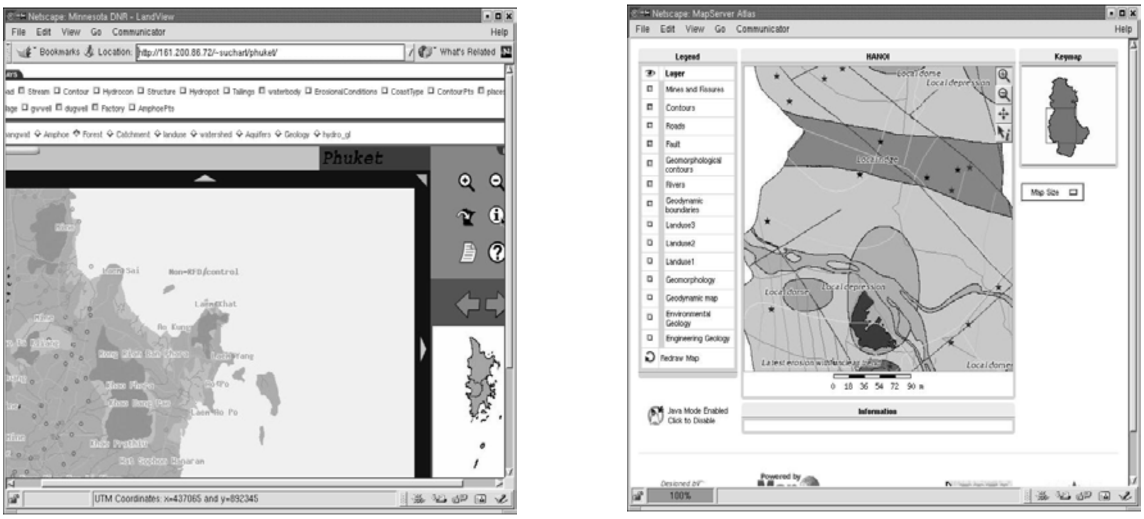

Figure. 8: MapServer application for (a-Left) Phuket Island, Thailand and (b-Right)Hanoi City, Vietnam