DEVELOPING AN ONLINE PPGIS PROTOTYPE BASED ON GEOVPMS – A FRAMEWORK FOR GIS-BASED VIRTUAL PUBLIC MEETING SPACE

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ABSTRACT:

This paper presents the prototype development of an integrated online GIS-enabled virtual public meeting space (GeoVPMS) system using open source technologies that are still in development and early stage of testing. The prototype system is based on a GeoVPMS conceptual framework (Li et al. 2007) and features the integration of various types of open source based solutions and open map services to provide web-based tools to support public participation in municipal planning processes. Although the broader project objectives are to develop a GeoVPMS that supports both asynchronous and synchronous participations, this paper focuses more on tools that support asynchronous participation, meaning that the public can participate in any time from any locations at their own comfort. The software implementation of the prototype focused on four important aspects of public participation, namely notification, information access, participation and feedback. The prototype demonstrates these functions.

1. INTRODUCTION

Municipal planning and development is an important and complex decision making practice for every local/municipal government. By laws, public participation in planning and development related issues, are major concerns nowadays. These issues may be partially resolved with Web-based participatory planning approach. According to Huxhold (1991), "good decisions are the best composition of good information". Based on a survey (Lowndes et al., 2001), public meeting is still one of the major means of improving public participation. It's true to some extent that public participation relies on efficient notification, participation and feedback. Holding public meetings or establishing online public information centers, with the help of Geographic Information System (GIS) and Web technology has been recognized as one effective way of gathering public input for the planning of municipal development projects (Tang, 2006).

It has been well perceived that the recent advances in the communication technologies, World Wide Web (WWW) and GIS have changed many facets of the traditional ways of public participation (Allen et al., 2003). As stated in Meredith (2000), appropriate gathering of data and information, robust connection to decision-making process and better tools for getting input into decision-making process can play a vital role in public participation. Over the last few years, we have seen a growing number of Public Participation Geographic Information Systems (PPGIS) applications to facilitate municipality groups and individuals. PPGIS provides a virtual space for spatial analyses during municipal planning and development with public input (Wong and Chua, 2001). Nowadays, several online PPGIS are available to empower the citizens to explore geospatial data related to municipal planning over the WWW (Evans et al., 1999).

1.1 Problems and Anticipated Solutions

First of all, based on observations from Evans et al. (1999) and Ventura et al. (2002), a few PPGIS frameworks allow the general public participants to post their comments and exchange views with each other effectively. In addition, a few online PPGIS prototypes/frameworks such as Argumentation Map (Rinner, 1999; Keßler, 2004) include participation forums to support multi-way communications among the participants until now. It is important to prepare an application framework that will be useful for sharing views, letting participants understand each other's positions and ideas. Furthermore, design and implementation of a spatial data handling component, GIS-based discussion forum, and notification system with the feedback support will be helpful as well as provide effective approaches for the public to explore the spatial contexts related to issues under planning. Moreover, the individual accessibility for the exploration of municipality areas under planning using spatial component will give choice to the public participants to initiate their discussion, by providing comments or inputs on the map, without gaining access to GIS-based forums.

Secondly, the implementation of Web-based PPGIS using proprietary software systems in the small municipalities may be too costly for the local bodies. Therefore, the small budget becomes one of the major hindrances in the design and implementation of GIS-based public discussion forums (Ma, 2006). A prototype has been analyzed, designed and implemented using UML approach to demonstrate a GIS-based

architecture with utilization of various free open source GIS and other Open Source Solution (OSS) tools.

Last but not the least, based on the survey by Ma (2006), many existing "Web-based PPGIS do not have a user-friendly interface for the general public". We anticipate that with the implementation of Human Computer Interaction (HCI) principles, i.e., strive of consistency (using Cascading Style Sheet (CSS) for fonts and colors), informative feedback (using Java-based dynamic effects of tooltips) and error prevention (JavaScript-based popup messages, etc.) as well as an accomplishment of the following attributes, the proposed prototype can provide efficient, interactive and user-friendly interfaces to the general public.

- Ease of use (visualization)
- User-friendly Interface (interactivity)
- Platform independent (any operating system)
- Good response time (client's perspective)
- Maximum throughput (system's perspective)

All these attributes represent key requirements in the prototype development life cycle and help in evaluating the successful design output at the end.

1.2 Objectives

The overall objective of the project reported in this paper is to present a prototype (GIS-based participation forum, spatial data handling component, notification system and feedback support) design and implementation based on the GeoVPMS model/framework introduced by Li et al. (2007) serving for spatially-related discussions in planning of municipality. In order to achieve this objective, attention is paid to the following questions:

1. To what extent proposed prototype fulfilled those needs by integrating the Web-based GIS with online participation forum component?
2. Does the design of a spatial data-handling component help the public to explore the spatial contexts related issues under planning with and without accessing the forum?
3. How does the usage of open source solutions end up with a cost-effective solution?
4. Does the prototype provide user-friendly, fast and accurate GIS-enabled public participation platform with knowledge-based resources?

The paper begins with an introduction of participation planning workflow with support of existing technologies during the municipal planning and development. The first section also points out some of the problems in existing PPGIS and defines the needs for such a system in supporting municipal planning, followed by a Unified Molding Language (UML)-based analysis and design of the proposed prototype. The prototype architecture with its Information Flow Model (IFM) and subsystem descriptions is then presented. We then present enabling technologies used in the design of the prototype with some of its interface designs, which support asynchronous participation by integrating Web-based GIS and open source GIS, e.g., University of Minnesota (UMN) Map Server, followed by the usability testing of sub-systems.

2. UML-BASED ANALYSIS AND DESIGN

2.1 Unified Modeling Language

The Unified Modeling Language (UML) plays a very important role in the analysis and development of object-oriented systems. The UML uses mostly standard graphical notations (UML diagrams) to express and document all the phases of a system development life cycle (i.e., problem initiation and identification, requirements gathering, analysis, design, implementation and testing). As municipality planning and development process workflow involves a complex decision-making process, whereas UML provides effective techniques to manage the complexity of such systems with both user's and system's development perspectives. Therefore, it is true in this regard that using UML and CASE tools (e.g., Rational Rose™) in the analysis and design of a prototype will result in a more effective and reliable solution.

2.2 Analysis and Design of the Prototype Subsystems

Object-oriented software engineering (OOSE)-based project life cycle using UML consists of five major models, i.e., requirements, analysis, design, implementation and test models, in which requirements model has a significant importance as it is mainly based on the data and business modeling (data workflow) concepts.

Requirements Model: In every system development life cycle, the requirements model plays the most important role during the system analysis and design. In addition, during this phase analyst develop a requirement specification which is helpful in identifying actors (system's users) and use-cases (system's functions from user's view). Stages of requirements modeling for the proposed prototype are shown in Figure 1:

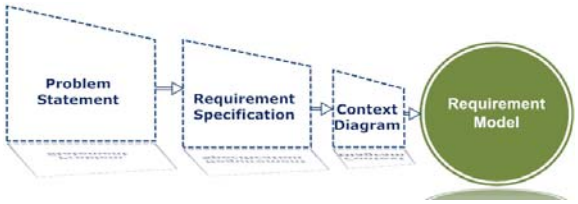

Figure 1. Stages of requirement modeling.

1) Problem Statement/User Requirements

It is usually given by the end users, but in this study, the statement criteria are developed by evaluating a few selected online existing PPGIS and mock-up Web-based PPGIS application scenarios by examining existing public participation practices in municipal panning.

2) Requirements Specification (RS)

The requirements specification includes the artifacts that are discussed briefly in the following sections. Figure 2 depicts the four major artifacts of RS for the proposed prototype.

Figure 2. Artifacts of requirements specification.

Overview Statement

The purpose of this paper is to develop GIS-based participation forum, notification system and feedback (voting/polling, etc.) components integrated under the general GeoVPMS framework based on OSS technologies for public participation in municipal planning and development activities.

Users/Actors

An actor/user is a person, organization, or external system that plays a role in one or more interactions with the system including:

- General Public Participant (Citizens)
- City Staff Members (Municipal/Local Bodies)
- Project Proponents and Domain Experts
- Spatial Database Administrator and Project Manager
- Environmental Assessment Researchers

Goals

- Faster and more facilitative GIS-enabled public participation forum and spatial component for exploring spatial data of particular municipality.
- Notification system for municipal planning related public notices.
- Knowledge-based resources with spatial contexts for naive and expert users.
- Address finder Application Programming Interface (API) feature enables users to access all meeting locations from their places.
- Feedback component handles two aspects: 1) Getting feedback from user. 2) Sending automatic response to registered participants in the form of newsletter and mailing list related to upcoming important events.

System Functions and Requirements

Table 1 briefly lists the major functional requirements identified. Some addition system attributes and non-functional requirements are as follows:

- Ease of use/user-friendly Interface
- Platform Independency
- Better response time and maximum throughput

F1-Projects List	Displays a list of the available projects under public consultation to the registered and non-registered users.
F2-Project Specification	Provides the detailed information of any selected project.
F3-Notification	Enables users, according to their assigned privileges, to view notices related to different projects of municipal development.
F4-Participation	User uses this sub component to explore the specific project with its spatial contexts and it allows user to store his/her comments that will become the future helpful idea for other participants. It is comprised of two major sub components: discussion forum and spatial data handler.
F5-Information Centre	Provides basic and expert knowledge of municipality planning related projects e.g., relevant by-laws, regulations, public meeting minutes, videos, conference papers, power point presentation, etc. to all participants.
F6-Feedback	This function is used to enable the feedback feature e.g., email, newsletters, voting, polling, etc.
F7- Meeting Location Finder	This function is a mashup of open map APIs (Google and Yahoo etc.) and PHP scripts. It enables user to find a location of the meeting place using open map services, i.e., Google maps.

Table 1. System functional requirements.

3. SYSTEM ARCHITECTURE

3.1 GeoVPMS Architecture/Informational Flow Model

GeoVPMS is a multifunctional framework, composed with different subsystems, for supporting municipal planning and development related issues. It is a Web-based GIS framework that introduces the concept of spatial context to an online public participation, collaboration and communication with the support of a Web-based GIS and a spatial database. The prototype, simplified version of GeoVPMS with selected functional components, has been designed using modular based approach. The following sections briefly describe the logical architecture of GeoVPMS from the infomation flow perspective (see Figure 3) and some of GeoVPMS's sub components.

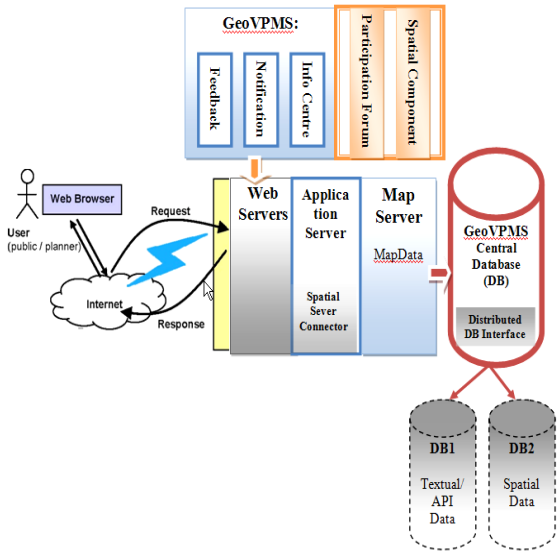

Figure 3. Logical architecture of the prototype DFM.

Figure 3 illustrates how the flow of data and information begins when the public send the request through HTTP protocol using client interface to Web server, which holds (Active Server Pages) ASP programmed components (i.e., direction API and info-center), and PHP-Hypertext Preprocessor programmed components (i.e., feedback and GIS-based participation forum) of the prototype. If the client requests the map information, the Web browser passes the request to application server (programmed using PHP map scripting modules), in order to fulfill the client request, the application server in turn communicates with the University of Minnesota (UMN) map server and central database of the prototype. The idea of using the n-tier architecture of the prototype increases the stability as well as reliability (throughput) of DBMS PostGRES with the better response time to the client. For instance, all textual data related to participation forum and other components are handled with DB1 whereas the data related to participation spatial components are stored in DB2 (i.e., PostGIS a spatial extension of PostGRES). Moreover, multiple participatory approaches are quickly manageable by two servers, i.e., Web Server and Map Server which enhances load balancing of the system. Details about prototype components are discussed in the next section.

3.2 Proposed Prototype Components

The prototype is a composition of some individual integral components. Some of these components are briefly described as follows:

Notification-- Public Notice System: Online GIS-enabled public notice system, called Notification, plays two important roles: (1) notifying the registered participants of upcoming public meetings/events using newsletter function and allowing the interested citizens to explore project information and become prepared for the public meeting; and (2) providing a platform for continuous soliciting of the public input and presentation of the final results (Li et al., 2007). The notification component also provides location mapping related function in which participant can find his/her way or direction to the public meeting place. For providing required direction services, Open Source (OS) Google APIs with a mashup of PHP server-side scripting language are used.

Info-Centre-- Information Resource Centre: In this component, the public can browse organized information related to the municipal planning and development problems. The documents include by-laws and regulations, project documents, meeting agendas and minutes, and the contact information.

Participation-- GIS-enabled Discussion Forum and Spatial Component: Participation component is mainly consisted of two major sub-components that are briefly discussed as follows:

(a) GIS-enabled Discussion Forum: The GIS-enabled online participation forum was designed and developed using Open Source Solution (OSS) technologies. This participation forum is embedded with another module, which handles all the GIS-based functionalities and can be enabled at any time during spatial contexts related discussion with other participants. The threaded forum messages are displayed in the main panel and the pop up window is used for GIS-based spatial component exploration. It initiates a concept of GIS-enabled discussion forum in which public participants can participate and share ideas of spatially-related discussion. The logical architecture of the spatial component with IFM perspective is shown in Figure 4.

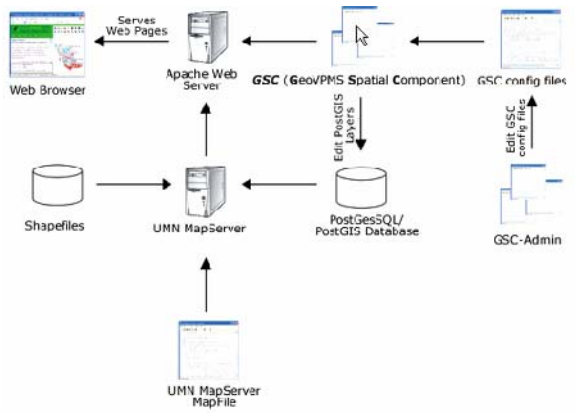

Figure 4. Logical architecture of spatial component.

(b) Non-forum based Spatial Component: Another component is designed for those participants who want to initiate their discussion without getting into the forum (see Figure 5). The purpose is to facilitate the user according to their ease or comfort by providing them the access to explore only a spatial component for participation associated to municipality planning related issues.

Feedback-- Public Feedback Component: The feedback module handles features such as newsletter, polling/voting and feedback from user.

4. PROTOTYPE SYSTEM

The following sections, with a walkthrough of major user interfaces of a module that supports synchronous participation, introduce the prototype constructed so far.

4.1 Software Tools and Technologies

The key considerations for adopting an OSS technology for the prototype development are: (1) supports Rapid Application Development (RAD); (2) easy to learn and set up; (3) readily available and preferably free of charge. Software and technologies that were used for the system analysis and design are: (a) Web servers (Apache, Internet Information Server); (b) Web mapping tools (MapServer); (c) Database server (PostGRES); (d) Server side programming (PHP and ASP); (e) Client side programming (XHTML, JavaScript, Dynamic HTML); and (f) CASE Tools and others (IBM Rational Rose™ and UML).

4.2 Implementation

The prototype was developed to demonstrate four important aspects that helps improve the participation process, i.e., awareness, information access, participation and feedback, as described in Section 3.2. This section describes the software implementation for supporting these aspects. First, a user opens up the project list drop-down menu from the top frame (see Figure 5), where he/she can view the important notice information regarding any project, whereas notice detail heading will be extended into sub-headings, i.e., notice title/subject, public meeting place and schedule information, meeting location finder and moderators.

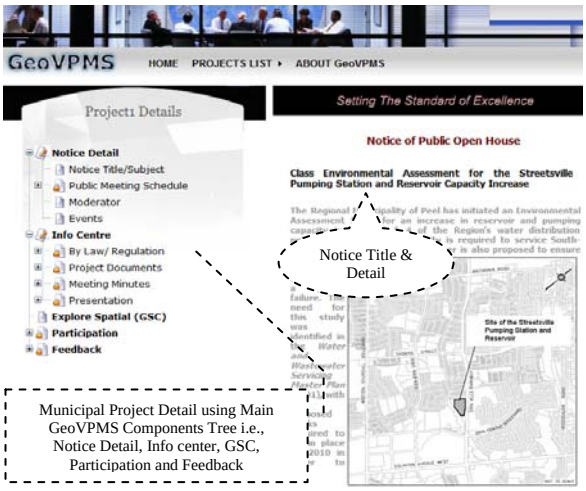

Figure 5. Main GeoVPMS interface with a list of projects under public consultation.

A GeoVPMS Spatial Component (GSC, see Figure 6) may be used for exploring project's spatial data without initializing discussion forum activities. Participants can access mapping functions, i.e., annotation, graphics, measuring areas, etc. Alternatively, participants can chose map-enabled discussion forum, where they can add his/her comments to the map and have some drawing functions as well as some other useful GIS functions such as select query, zoom in, zoom out, query by attribute, erase graphics, identity feature, measure area and pan tools. Figure 7 show the main interfaces of GIS-enabled discussion forum and spatial component.

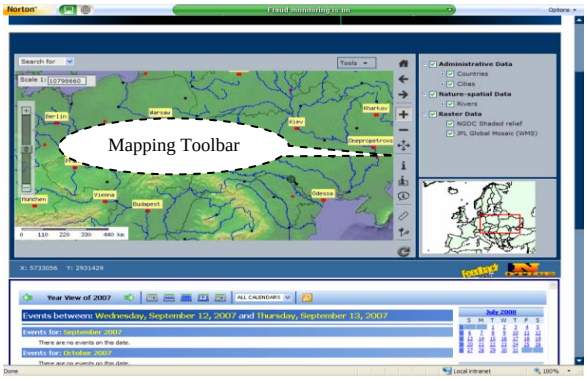

Figure 6. Main interface of the GSC.

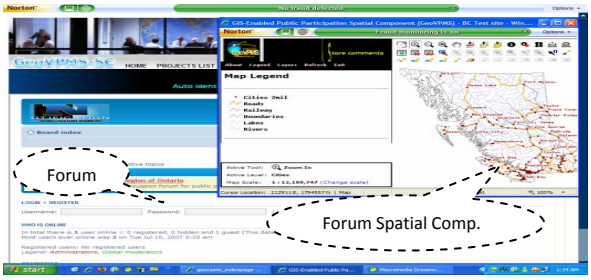

Figure 7. Main interface of GIS-enabled discussion forum.

Apart from basic mapping functions, another important feature of this component is save/load session (see Figure 8) with particular map information, which can be added in discussion. User can store the map information session and attach saved session with discussion forum in his/her posting, whereas another user can view or alter the saved map information and repost it.

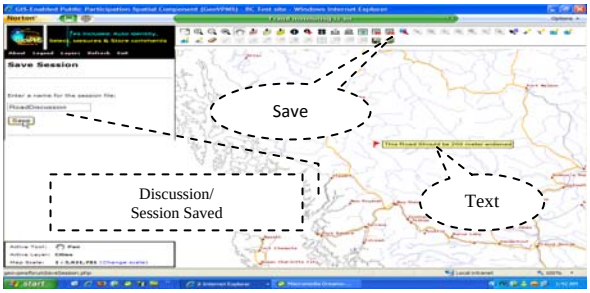

Figure 8. Adding text and saving session interface.

Other software implementations focus on functions for public notification and feedback. For example, the feedback functions provide user polling/survey interfaces, which can either directly

be accessed through the project's detail window or from the main interface of feedback.

4.3 Testing and Evaluation

The prototype testing and evaluation was initially limited to usability testing, evaluating the software implementation described above on six randomly selected students. A so-called "hallway-testing" technique was followed. The six testers (2 female and 4 males) have different professional backgrounds (i.e., business, computer science and GIS) of ages between 18 and 40. They walked through some of the GeoVPMS subsystems major functions (developed so far) to determine whether/to what extent these functions meet design objectives and requirements. Figure 9 below illustrates the system environment used for testing.

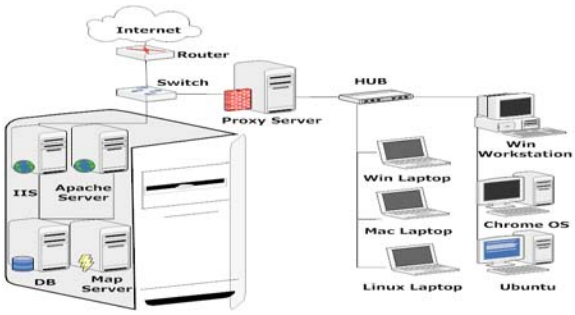

Figure 9. Usability testing environment of GeoVPMS

Some observations derived from the usability testing are: (1) some tester experienced performance (i.e., system response time, etc.) variations when the GIS-enabled components were accessed through WAN and LAN environments; (2) performance analysis of most of the GeoVPMS components is based among three categories (viewers, participatory users and GIS experts) of testers, for instance, those who have the zero knowledge of using forums and GIS functions have the lowest interest and fewer performance measures of usage as compare to those who have more knowledge of initiating topics during forum-based discussions with GIS mapping functionalities; and (3) younger testers with more computer knowledge have less interest (less performance measures) in exploring and using GeoVPMS components as compare to those who are older. For example, it might be a case that most of the young generation (ages 24 and up) has less interest in urban development related projects as they have less buying power and therefore, they avoid participatory planning activities during the new municipality development.

5. CONCLUDING REMARKS

GeoVPMS subsystems are designed to provide both synchronous and asynchronous support of participation, by integrating GIS functions in all aspects of public participation including notification, information access, participation and feedback. Similar to other PPGIS, GeoVPMS does not make the decision itself but can help improve participation and the decision-making process.

Developing the spatial data-handling components with and without forum-based support provides flexibility in facilitating the public to explore the spatial contexts related issues under planning. The purpose is to facilitate the user according to their ease, for instance, some people may not like to participate using the discussion forum.

The prototype framework is designed by using free OS-GIS and OSS-based technologies, therefore, providing the cost effective solutions for small municipalities. As the prototype development is based on object-oriented procedures, further enhancement of the prototype is practicable.

6. ACKNOWLEDGEMENT

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