Interactive Digital Office Automation System Mapper - IDiOM

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Submitted to the faculty of Computer Science, Military College of Signals, National University of Sciences and Technology, Rawalpindi in partial fulfillment for the requirements of a B.S degree in Computer Science

July 2010

CERTIFICATE

Certified that the contents and form of project report entitled **“Interactive Digital Office Automation System Mapper - IDiOM”** submitted by 1) Maj Syed Irfan Saeed, 2) Maj Mujtaba Anwar Raja, 3) TC Muhammad Jehanzeb Sohail and 4) TC Mansoor Ahmed have been found satisfactory for the requirement of the degree.

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ACKNOWLEDGMENTS

First of all we would like to thank Allah Almighty. Whatever, we have achieved; we owe it to Him, in totality.

We are really grateful to our parents, family and well-wishers for their admirable support not during the course of the project, but also throughout our lives for without them, all this would have never been possible. They have always been behind our every success and are the major stimulating force that facilitates us in achieving what we aspire.

We would like to thank our Project Supervisor Lt Col Dr Faheem Arif, We would like to thank him for his motivation and guidance throughout the Project and making it a tough job possible, and gave us the opportunity to polish our skills and guided us into this area of learning. We would thank Faculty of Military College of Signals for their untiring efforts. This project has been brought to shape by their consistent assistance.

We would also like to thank Maj Hammayun Yousaf C4I dte GHQ for his guidance in making this project possible.

ABSTRACT

INTERACTIVE DIGITAL OFFICE AUTOMATION SYSTEM MAPPER IDiOM

Introduction of automation in various professions has not only reduced the reaction time of different organizations but it has also increased their efficiency manifold. This changing scenario demands Army in general and field formations in particular to adopt such techniques to increase their battle efficiency. The project is mainly aimed at creation of a system consisting of a Web Map Server and a User end application for the manipulation of maps.

Main methodology of IDiOM is to place different tools in the workspace in order to explore different resources and link further details of plans and data. This is being done by making interface and establishing a database with an efficient use of maps available on Pakistan Army intranet; the potential users will be able to register themselves on the website. A user having PA number can only register him, which will be verified by administrator of IDiOM. Once the user is verified by the administrator, he will be given certain rights for the manipulation of maps.

The application is based on simple query syntax for posting a request for the desired layers and zoom window to the server, which returns a map as a standard picture .Routes, units and important installations will be marked on these entities, where the authorized users will be given full access to change/update the locations and feature.

The integrity of maps has been validated before uploading on GeoServer. The application has also been successfully tested on various browsers to check the compatibility issues creation, updating and transportation of plans has also been tested and validated.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter introduces the proposed research area, the goal of the project, its general background and outline adopted to achieve the objectives.

1.2 Problem Statement:

Introduction of automation in various professions has not only reduced the reaction time of different organizations but it has also increased their efficiency manifold. This changing scenario demands Army in general and field formations in particular to adopt such techniques to increase their battle efficiency. Pakistan Army has recently moved on to Office Automation System (OAS) to cope with these challenges, though still OAS lacks the functionality of GIS mapping. Interactive Digital Office Automation Mapper (IDiOM) is designed to be a subsystem of the OAS which will deal with some of the GIS related needs of Pak Army.

1.3 Purpose

The project specifically aims at indigenously developing a web based interactive mapping application where different types of maps and imageries of desired areas are available in a database and they can be used to make plans and military markings on the overlays which can be saved and exported for the commanders in the field.

1.4 Project Scope Statement

To create a system consisting of a Web Map Server and a User end application with the help of digital maps, satellite images, and terrain info and vector maps for display and updating of military resources using tool.

1.5 Motivation

The science linking GISs and the Web, known as geographic information retrieval (GIR), was first introduced by Larson in 1994. GIR is concerned with providing specialized access to geo-referenced information sources. Using the Web with GISs, Army can be provided access to

GIS databases and simulation models to plan out their military action who otherwise would not have access to the technology but whom would find the information useful in their decision-making activities. In the past, the high cost of hardware and software prohibited individuals

from having their own GIS. Web-based GISs will remove the barriers of high cost and difficult learning curves.

1.6 Research Domain

The Research Domain of our project is Geographical information systems linked with a web based application and geospatial database based on a thin client architecture .

1.7 Achievements

This project was done with guidelines from Army Survey Unit, Rawalpindi and C4I dte .It has been presented to various officials from Pakistan Army and also been displayed at Compec 2010 at College of E&ME.

1.8 Future

This project can be further extended by improving the security of the classified maps on the web application and by adding further functionalities to the web portal.

1.9 Organization of Report

This project report has been divided into eight chapters. Chapter 1 gives an introduction to the technology used and project statement and motivation behind under taking the project. Chapter 2 gives the literature review in detail along with the appropriate references. Chapter 3 is based on the detailed

analysis of system requirements. Chapter 4 describes the system design and architecture and explains the way project is organized. Chapter 5 describes the system development with all the details of the system functions and explains the way they have been developed. Testing and validation of the system is explained in chapter 6, chapter 7 comprises of Results and Analysis and finally chapter 8 describes all the achievements of the project and the forums where it has been presented also including the future work that can be done in the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the literature that we have studied so far. It includes the different approaches being considered for developing a Web based GIS system , Different client architectures and the problems and shortcomings of those architectures. Further this chapter also includes a detailed description of all GIS technology and their related work and explains the main area of knowledge which one should have an idea of before developing a GIS system.

2.2 GIS Technology and Related Work

Geographic Information System (GIS) is a collection of methods to visualize, manipulate, analyze, and display geographically referenced data or geospatial data. The sources of geospatial data are digitized maps, aerial photographs, satellite images, statistical tables and other related documents. GIS visualization services enable maps, these maps links databases to the maps. These databases keep geospatial data in the predefined form such as binary, xml, string etc. Explaining geographic data by pictures (maps) is much more powerful than explaining same thing by numbers.

GIS relates different information represented in spatial context. For example state boundary lines data can be analyzed and produce a map. By the same way, fault data can be analyzed and produce a map. GIS relates these two data sets by overlaying these two maps produced from the corresponding data and reach a conclusion about this relationship.

Following are the definitions of some commonly used terms in the GIS. These terms will be used in the following chapters.

SPATIAL DATA:

Spatial data are a kind of data that pertains to the space occupied by objects. Example spatial data from the real world are cities, rivers, roads, states, crop coverage, mountain ranges etc. In the implementation these are represented by points, lines, rectangles, surfaces, volumes etc. Spatial data have some common characteristics. These type of data are geometric data and in high dimensions. These data can be either discrete (vector) or continuous (raster). GIS applications are applied on these types of data.

GEOSPATIAL DATA:

Geospatial data are spatial data associated with a location relative to the Earth.

FEATURE:

A feature is an abstraction of a real world phenomenon. A digital representation of the real world can be thought of as a set of features.

GEOGRAPHIC FEATURE:

A geographic feature is a feature associated with a location relative to the Earth. Geographic features are those that may have at least one property that is geometry-valued.

VECTOR DATA:

Vector data deals with discrete phenomena, each of which is conceived of as a feature. The spatial characteristics of a discrete real world phenomenon are represented by a set of one or more geometric primitives (points, curves, surfaces, or solids). Other characteristics of the phenomenon are recorded as feature attributes. Usually, a single feature is associated with a single set of attribute values.

RASTER DATA:

Raster data deals with real world phenomena that vary continuously over space. It contains a set of values, each associated with one of the elements in a regular array of points or cells. It is usually associated with a method for interpolating values at spatial positions between the points or within the cells.

SPATIAL REFERENCE SYSTEM:

A spatial reference system is a function which associates locations in space to geometries of coordinate tuples in a mathematical space, usually a real valued coordinate vector space, and conversely associates coordinate values and geometries to locations in the real world.

TEMPORAL REFERENCE SYSTEM:

A temporal reference system is a function that associates time to a coordinate (usually one dimensional points and intervals) and conversely associates coordinate geometries to realworld time.

SPATIAL-TEMPORAL REFERENCE SYSTEM:

A spatial temporal reference system is an aggregation of a spatial system and a temporal system that it uses to associate coordinate geometries to locations in space and time. Normally, the aggregation uses orthogonal coordinates to represent space and time, but this is not necessarily the case in more complex, relativistic environments.

SCALABLE VECTOR GRAPHICS:

Scalable Vector Graphics is a family of specifications of an XML-based file format for describing two-dimensional vector graphics, both static and dynamic .SVG images and their behaviors are defined in XML text files. This means that they can be searched, indexed, scripted and, if required, compressed. Since they are XML files, SVG images can be created and edited with any text editor, but specialized SVG-based drawing programs are also available

Drawback:

All major modern web browsers except Microsoft Internet Explorer (IE), support and render SVG markup directly.

2.3 Web GIS Architecture

Various GIS architecture had been studied during the literature review and compared against each

other to find the best solution for on user requirements. Before we mention the different architecture one should be aware of how Web GIS works

2.3.1 Working of Web GIS

Web GIS is similar to the client /server typical three-tier architecture. The geo-processing is breaking down into server side and client side tasks. A client typically is a web browser, where as the server side consists of a Web Server , Web GIS software and Database as shown in the figure below :

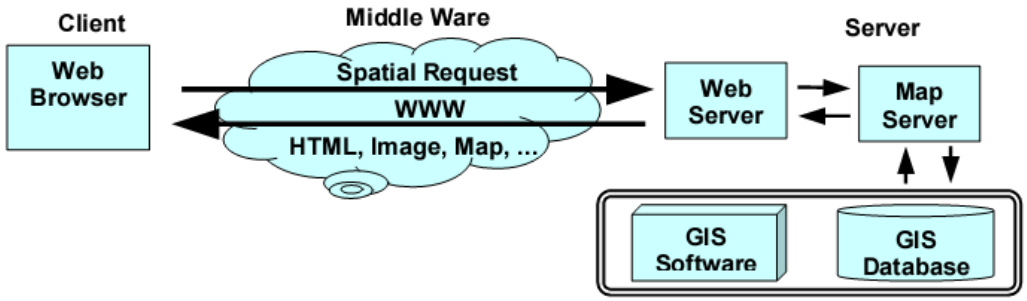

Figure 2.1

Working of Web GIS model

This model of network widely exists within enterprises, in which some computer acts as servers and others as clients. Servers simply have the proprietary GIS running and add a client interface at the client side and a middleware at the server side to communicate between the client and the proprietary GIS software.

Recent development in object oriented programming has made it possible to produce software components and send them to the client before running it in the client machine, such as Java classes,

ActiveX components and plug-ins. This comes out to thick client GIS. The thick client architecture let the client machine do the most processing woks locally. Both thin client and thick client architecture have some advantages and drawbacks, but they are not the best in terms of taking advantage of network resources.

Below various architectures has been explained in detail.

2.3.2 Thin Client Architecture:

The thin client architecture is used in typical architecture. In a thin-client system, the clients only have user interfaces to communicate with the server and display the results. All the processing is done on the server actually as shown in Figure 2.2

The server computers usually have more power than the client, and manage the centralized resources. Besides, the main functionality is on the Server side in thin architecture there is also the possibility for utility programs at the server side to be linked to the server software.

Figure 2 shows schematic communication between Web browser, Web Server and GIS server.

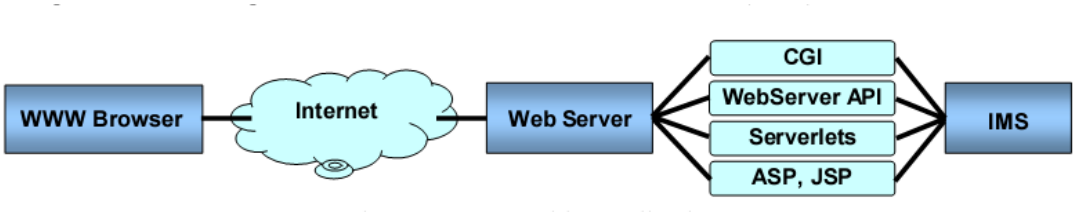

Figure 2.2 Server side Application

The user on the client side does not need any knowledge about the linkage of the IMS at the server side, but the system administrator or application developers should be familiar with these techniques.

Major advantages of this model driven form Data Base centralization and are:

- Central control
- Easy for data eminence/updating
- Keep the latest version
- Generally cheaper

  Integration possibilities

And disadvantages are.

- Not responsive to local needs: users have different invokes
- Large data volume (size of the database)
- Response time slow: users use a browser and it take long time to download new HTML frame
- Vector data does not appear in client side: browsers without additional plug-in can not read vector files

2.3.3 Thick Client Architecture

In general, a Web browser can handle HTML documents, and embedded raster images in the standard formats. To deal with other data formats like vector data, video clips or music files, the browser's functionality has to be extended. Using exactly the same client sever communication in Thin Client

architecture, vector files format could not be used. To overcome this problem most browser applications offer a mechanism that allows third tier programs to work together with the browser as a Plug-in.

The user interface functionality has progressed from simple document fetching to more interactive applications. This progress is as follows: HTML, CGI, using HTML forms and CGI, Java script to increase user interface capabilities, Java applets to provide client-side functionality. Currently user interface capabilities combined with remote invocations (Figure 2.3)

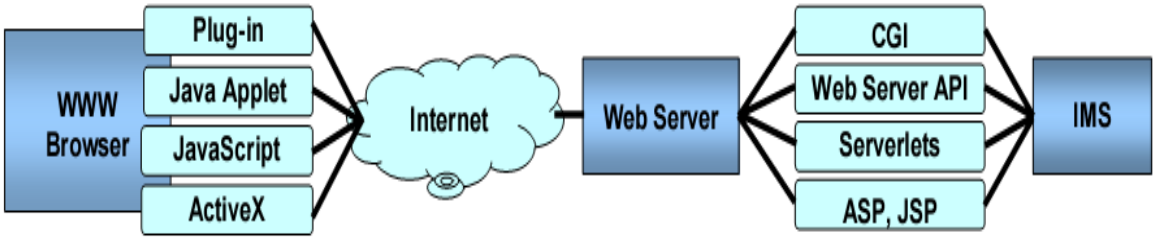

Figure 2.3. Client side application

Major advantages of this model are:

- Document/graphics standards are not required
- Modern interface is possible; it is not restricted to single-click Operations
- Vector data can be used
- Image quality not restricted to GIF and JPEG

And disadvantages to Client Side GIS

- Nonconformance cans limits
- Users require to obtain additional software

- User base

2.3.4 Medium Client Architecture

For avoiding vector data in client side and reducing problems of previous architectures, Medium Client is suggested. With using extensions in both client and server side, clients may have more functionally than Thin client architecture. In Figure 2.4 these four components in interactive map are pictured as services, each with interfaces, which can be invoked by clients of that service.

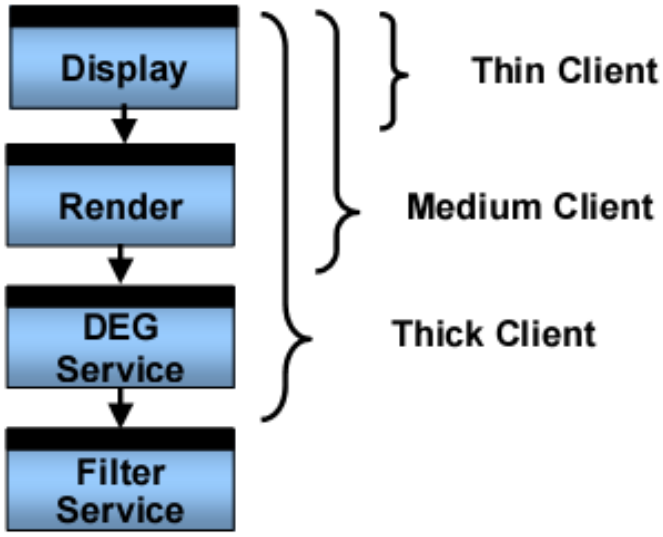

Figure 2.4. Medium client position in Open GIS

In other words, if a user's computer contains just the display service, then that user would be said to be using a thin client. If the user's computer additionally contained a render service, then that user would b e said to be using a medium client. And finally, if the user's computer also contained the display element

generator service that would indicate the user is using a thick client. After some consideration, it was decided that while this distinction may be somewhat helpful in describing web mapping, the terms “thick client” and “thin client” were already encumbered by very imprecise definitions used in marketing literature and were therefore not suitable for continued use in some cases.

2.3.5 Distributed Architecture

Recent developments in information technology have resulted in a number of distributed object architectures that provide the framework required for building distributed applications. The framework also supports a large number of servers and applications running concurrently. Many of such frameworks provide natural mechanism for interoperability .For example, Distributed Component Object Model architecture in windows platform and Java Remote Method

Invocations (RMI) in Java Virtual Machine (JVM) are the most popular protocols that are used in different cases. These architectures may be applied to GIS to improve the traditional client/server GIS model and develop scalable distributed GIS model. Some attempts have been made in the academic area.

The general idea of the distributed GIS service model is that a client program, in either an Internet browser or an independent application, should be able to access the resources distributed in the entire network. The resources here refer to both geodata and geoprocessing components available in the network. The client and the server in this context do not refer to a specific machine. Any machine, when it requests the remote resources during the processing, is a client, and any machine that provides such resources is a server. In a specific program, a client may connect to several servers if needed and a specific machine may be the client at one time and the server at another time. An ideal distributed GIS service model should be a "geodata anywhere, geoprocessing anywhere" model, which means the

geodata and geoprocessing tools could be distributed with the largest flexibility virtually anywhere in the network. The geodata and geoprocessing components do not have to be in the same site, but they should be able to cooperate or integrate whenever they are needed to finish a specific task.

2.4 Categories of multimedia web GIS

HTML plays a robust role in the development of the Multimedia Web GIS. On the one hand, HTML provides limited facilities (in forms of limited tags) to incorporate multimedia and GIS, but on the other hand, HTML provides unlimited facilities, in the form

of its capabilities to incorporate applets, plug-ins, ActiveX, and future type of embedded. Through HTML our multimedia Web GIS can be viewed into three different categories. These are Static Web GIS, Dynamic Web GIS, and Active Web GIS

2.4.1. Static web GIS

Web GIS, enable GIS user to manipulate GIS data and maps on the Web interactively. The users can browse the Web page through the hypertext linkage. Each Web page is a static image organized by the Web developer. Static pages are static HTML pages

that are prepared in advance of the request. A geographical document from a static Web GIS is stored as a file and its contents are determined by its author when it is created. The GIS Server returns the HTML pages to the user, but takes no special action. The user requests a static page by typing in an URL or by clicking a link pointing to an URL. The URL request is sent to the GIS Server. Therefore, each request for a static multimedia map documents results in exactly the same response. Strictly speaking, this should not

be called GIS at all, for it lacks the ability to analyze geographical data.

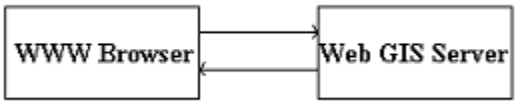

Figure 2.5. Static Web GIS

2.4.2. Dynamic web GIS

GIS also can take advantage of Web's dynamic ability. Dynamic pages are created in response to a user's request. A multimedia geographical document from a dynamic Web GIS is not stored as a file, but created by a dynamic Web GIS whenever a browser

requests the document. Because a fresh multimedia geographical document is created for each request, the response of a dynamic Web GIS varies from request to request.

A Web browser collects information by presenting a page with text boxes, menus, or check boxes that the user fills in or selects. When the user clicks a button on a form, the data from the form is sent to the GIS Server. The GIS Server either passes the data to a

Script or application to be processed or it queries or posts data to a database. The GIS Server returns the results dynamically to the user in an HTML page. Each time user accesses the site he/she will view the different information depending upon the users request. Web GIS is dynamically linked with the sources.

This dynamic linkage with the sources always keeps the data and software current. On the server site, the CGI (Common Gateway Interface) script will be responsible to provide real-time multimedia information. Web GIS can link with multimedia real-time information by real-time connection with the relevant information sources.

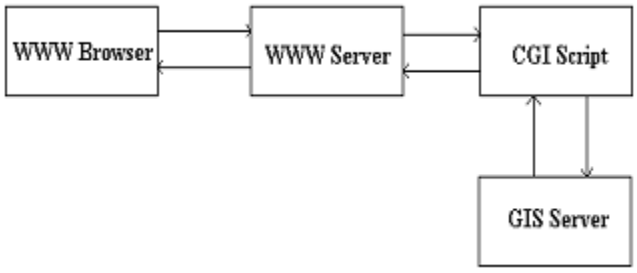

Figure 2.6 Dynamic web GIS

2.4.3. Active web GIS

A geographical document from an active Web GIS is not fully specified by the server, but a computer program that can run on the browser's local machine, can interact with the user and change the display continuously, and can use the multimedia geographical data at the server. When a browser requests a map document from an active

GIS Server, the server returns a copy of the program and then the browser runs it locally at the client machine. HTML allows creating active documents through a number of ways such as ActiveX Controls, Java Applets, JavaScript, VB Script, and so on.

2.4.3.1. Active control web GIS:

HTML allows ActiveX Controls to create any user-defined Controls. One way to develop multimedia Web GIS is the use of ActiveX Controls to create GIS Controls. ActiveX is developed by Microsoft to "activate the Internet". An ActiveX Control is a program, or an executable file that exposes certain methods, properties, and events through a programmable interface. An ActiveX is a modular piece of software that performs tasks and communicates information. It can be used and reused by any program or computer language that is able to contain ActiveX Controls, such as Web browser, for example, Internet Explorer and Netscape Navigator (with certain plug-ins installed) or languages, or example, Visual Basic, Visual C++, FoxPro. GIS Controls have computational power,

communications power, and powerful graphic interface, and can be used like plug-ins and Java applets within Web browsers.

2.4.3.2 Java applets based web GIS:

HTML allows incorporating any kind of applet as a part of HTML document. Java applets based Web GIS is the most recent flavor of multimedia Web GIS. Java applets

are mini applications that run inside a Java enabled Web browser. Java applets are executed on a client site on demand. It provides a wide range of tools for creating and displaying graphics, and manipulates GIS data on the Web. Each GIS function for example zoom in, zoom out, query, label and the report of query output etc. could be one separate Java applet.

2.5 Comparison between Desktop and Web Application

A detailed comparison between desktop and web application is shown in Table 2.1

Desktop	**Web**
Platform dependent	Platform independent.
Installation necessary.	No installation required.
Thick client , maintenance needs maximum	Thin client; maintenance is minimized.
Difficult to integrate with existing applications.	Easy to integrate with existing applications.
New, unfamiliar interface.	One common, familiar interface across applications.
Difficult to add multimedia	. Easy to add multimedia.

Table 2.1 Comparison of Desktop and Web Application

2.6 Open GIS Consortium (OGC)

The OGC Implementation Specifications are a set of interfaces that specify the request and response protocols for the interaction between open web-based servers and client. Two of the specifications are the Web Map Service Implementation Specification and the Web Feature Service Implementation Specification. In a situation where multiple servers implement e.g. the OGC WMS Implementation Specification, a client application would have the possibility of accessing map data from each server, and

merge them in to one picture. For example, one server could be asked for a map layer showing all mountains in a specific area of the world, another server could be asked to provide a map layer of all lakes in the same area, and a third server could be asked for a map layer showing all cities in the area.

	Standard	Description.
Mapping	Web Map Service (WMS 2004)	The WMS specification defines an interface to allow mapping services to be made accessible over the web.
	Styled Layer Descriptors (SLD 2004)	The SLD allows map specifications to be defined. It encodes concepts for specifying the content, the map 'layers', and presentation, the layer 'styles' of a map.
	Scalable Vector Graphics (SVG 2004)	SVG is an XML encoding to describe graphics using vector primitives. (c.f. Lehto and Kilpeläinen 2000, Cecconi and Galanda 2002, Reichenbacher 2002, Takagi *et al* 2003).
Data Handling	Web Feature Service (WFS 2004)	The WFS specification defines an interface for accessing spatial data, as geographic features, over the web.
	Geography Markup Language (GML 2004)	GML is a protocol for encoding geographic feature descriptions in XML. GML uses standard conceptual abstractions (ISO 19107, ISO 19109) as a data schema for classifying features, their attributes and geometries.
	Filter Encoding (FES 2004)	The filter encoding specification provides a neutral protocol for constraining spatial and semantic queries on spatial data resources (e.g. a WFS).
Web Services	Web Services Architecture (WSA 2004) - Simple Object Access Protocol (SOAP 2003) - Web Services Definition Language (WSDL 2001)	The Web Services Architecture (WSA) is a collection of protocols and standards to allow software applications to interoperate over the internet in a platform independent manner. Two of these are: - SOAP is a light-weight implementation of a WSA protocol. It allows access to objects, operations or data over a network using structured messages in XML. - WSDL a WSA protocol to describe the interface of a Web Service. It allows the service to expose the operations and message formats it supports.

Table. 2.2 Description of OGC Services and Standards

These map layers can be requested by a client application and shown by the client as one map picture, with all three layers merged into one. All three servers are asked for the layer in the same way, since it is specified in the WMS Implementation Specification how a request for a map layer shall look like. The lack of interoperability is no longer present.

With the OGC Implementation Specifications, the isolated technology islands do not only develop bridges between each other, they are merged into one big continent where spatial data is easily exchanged between the different servers and clients.

2.7 OGC Web Services

OGC Web Services is the definition of the standard interfaces and protocols, encodings and schemas, for Web Services that handle geo-spatial information. OGC Web Services support today only one distributed computing platform, Internet, and the Hypertext Transfer Protocol (HTTP) is used. Since the area of web mapping is a large area, one interface specification is not sufficient to accomplish a freely exchanging of spatial information. Therefore, there exists several OGC Implementation Specifications.

2.7.1Web Map Service (WMS)

One of the most famous specification of all OGC Specifications is the WMS Implementation Specification. It describes the functionality of an OGC Web Map Service

2.7.1.1 Web Map Server

The functionality of a WMS server is to produce maps. A map is not defined asthe geo-referenced data itself; it is a visual representation of the geographical data. When a client requests a map from a WMS server, a number of things can be specified in the request, e.g. what information the client wants to be presented on the map, what part of the earth that the client is interested in , the size and format which is desirable for the retrieved map, the background color and transparency, and the coordinate reference system to be used. If the client asks for more than one map, and the requested maps are of the same part of the world, the same coordinate reference system and have the same output size, all maps can be merged together into one map which is retrieved by the client. With a transparent background, lower map layers are visible through upper

map layers. It does not matter if the different map layers come from the same WMS server or from different WMS servers, as long as the essential parameters are the same, they can be merged into one map picture. The specification enables web map clients to easily choose among different servers, each providing different map data, and build maps with the information that they need .

Thus, the WMS Implementation Specification is a great advantage for all web map clients around the world, but it also serves a purpose for the suppliers of spatial data. Since WMS clients can freely choose and access WMS servers through a common interface, the same spatial data does not have to be served from more than one WMS server. This fact saves time and cost for holders of WMS servers and suppliers of spatial data.

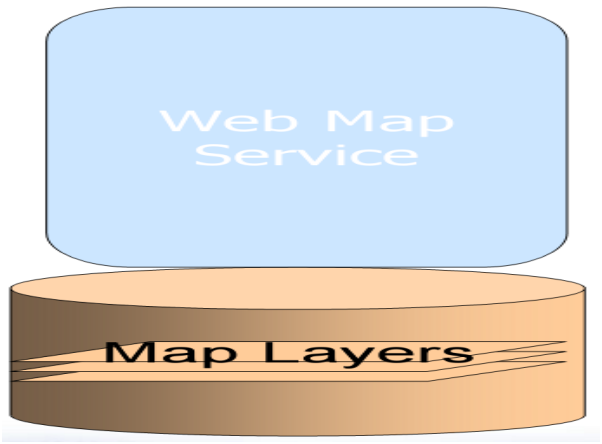

Figure.2.7 Web Map Service overview

2.7.1.2 Working of WMS

To send a request to a WMS server, the only thing needed is a web browser. By specifying. The request in the form of a Uniform Resource Locator (URL), the server will respond. How the URL should be constructed depends on the chosen request. Common for all URLs is that they require a version number and a parameter telling the server which of the request types is chosen. With the GetMap request, the client is allowed to specify a number of additional parameters in the URL request, e.g. what information

the client wants the map to show and what part of the world the map shall visualize, If the client wants to retrieve information about a certain feature shown on the map and the GetFeatureInfo request is specified, the client needs to specify in the URL, the map that is being queried and also the location on the map, which is of interest.

2.7.2 Web Feature Service (WFS)

The OGC WFS Implementation Specification is a specification for how to handle geographic features on the Internet. In the interaction between a client and a WMS server, static images are sent over the web. In the client interaction with a WFS server, the geo-spatial data exchanged is encoded in Geography Markup Language, GML.

The OGC WFS Implementation Specification describes the functionality of an OGC Web Feature Service.

2.7.2.1 Web Feature Server

The request to a WFS server is a query for one or more features that can be delivered by the server. The transport protocol used is HTTP. When the server receives the request, it executes the request and sends back the requested information to the client.

2.7.3 Web Coverage Service (WCS)

The Open Geospatial Consortium Web Coverage Service Interface Standard (WCS) provides an interface allowing requests for geographical coverage across the web using platform-independent calls. The coverage are objects (or images) in a geographical area, whereas the WMS interface or online mapping

portals like Google Maps return only an image, which end-users cannot edit or spatially analyze.

2.8 Map Servers

2.8.1 ArcGIS

ArcGIS is a suite consisting of a group of geographic information system (GIS) software products produced by ESRI. At the desktop GIS level, ArcGIS can include: ArcReader, which allows one to view and query maps created with the other Arc products; ArcView, which allows one to view spatial data, create layered maps, and perform basic spatial analysis; ArcEditor which, in addition to the functionality of ArcView, includes more advanced tools for manipulation of shapefiles and geodatabases; or ArcInfo which includes capabilities for data manipulation, editing, and analysis

Drawbacks of ArcGIS

ESRI's change to the ArcGIS platform rendered incompatible an extensive range of user-developed and third-party add-on software and scripts. A substantial user base resists migrating to ArcGIS because of changes in scripting capability, functionality, operating system as well as the significantly larger system resources required by the ArcGIS system.

ArcMap and other ArcGIS applications have a tendency to crash from time to time, while some of its geoprocessing tools fail when processing moderately large datasets. Other issues with ArcGIS include high prices for the products, proprietary formats, and difficulties of porting data between ESRI and other GIS software

2.8.2 GeoServer

GeoServer is Web Server written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards.

GeoServer is the reference implementation of the Open Geospatial Consortium(OGC)Web Feature Service (WFS) and Web Coverage Service (WCS)standards, as well as a high performance certified compliant Web Map Service(WMS). GeoServer forms a core component of the Geospatial Web. As per user requirement Geoserver was selected as a Web Map Server for our project.

CHAPTER 3

REQUIREMENT ANALYSIS

3.1 Introduction

Requirements analysis encompasses those tasks that go into determining the needs or conditions to meet for a new or altered product, taking account of the possibly conflicting requirements of the various stakeholders, such as beneficiaries or users. Systematic requirements analysis is also known as requirements engineering. Requirements analysis of IDiOM is done in this chapter.

3.2 Existing System

The present system used in Pakistan Army is OCCS, a Chinese software, which is used for mapping. The basic purpose of this software is to upload maps of different areas, to make military plans over those maps and then send them to other field formations. The officer who receives this plan uploads it on his system and then executes it accordingly. The software supports to draw military symbols and free hand drawing.

3.3 Problems with Existing System

The existing software used in Pakistan Army is OCCS. It is a desktop application. It is very heavy and expensive software which needs a very strong machine to run. The maps take too much time to display; therefore this software has very low efficiency. Most of officers prefer to do

hand work instead of using this software due to its response time. So this software is no more in use in most of the Pakistan Army units.

3.4 Requirements Consolidated

Based on the problems of the current system and guidelines from the Army Survey Unit 477 and C4I dte, requirements for our project were consolidated. It was desired that the application should be web based. Another critical requirement was to make the system simpler for army field commander. The system fulfils all these requirements. The application is web based providing the entire feature of OCCS. IDiOM offers functions for free hand drawing, make overlays, draw military symbols, turn on/off different layers, add/delete layers, change position of different layers, change layers style, search area by name, change color of some area on layer etc. Since satellite images are very heavy so the problem was response time. To cater this issue we have incorporated tiling in our system. The system does not load whole map at once, it is being done in parts which definitely reduces the response time. We have also incorporated cache using a tool in our system. Now on every user request the system does not need to load maps from database, the map once requested is loaded into cache and on the next request for the same map; it is sent from cache straightaway.

3.5 Functional Requirements

The requirements related to the functionality of the system are functional requirements of the system. Following are the functional requirements of our system.

- Uploading of maps/satellite and aerial imagery/resources data.

- Enable Searching for the map of a particular area from Web Map Server
- Display of maps/ images/resources data.
- Making and saving of overlays/ plans as per Pak military symbols and abbreviations.
- Export/Import of overlays/plans.
- A very user friendly GUI and easily understandable search and marking techniques.
- The application is basically consist of three parts;
    - The look up module which host user queries.
    - The map display module which also contains all the tools to manipulate the uploaded data such as zooming, panning fit all etc.
    - The overlay marking and manipulation module where user is able to make, save, export and import overlays.

3.6 Interface Requirements

The IDiOM is to be used by the Army field commanders for making several plans. The army field commanders are not expert computer programmers. Instead they have a little knowledge of the system. The GIS based software's are very complex in nature. Best utilization of the system can only be made if it is simplified for field military commanders. Keeping this constraint in mind, the IDiOM is designed to be very user friendly. The user can select the map of some area by simply entering the name or code of that area. The self-explanatory tools are available for drawing military plans. The GUI is depicted in the figure 3.1.

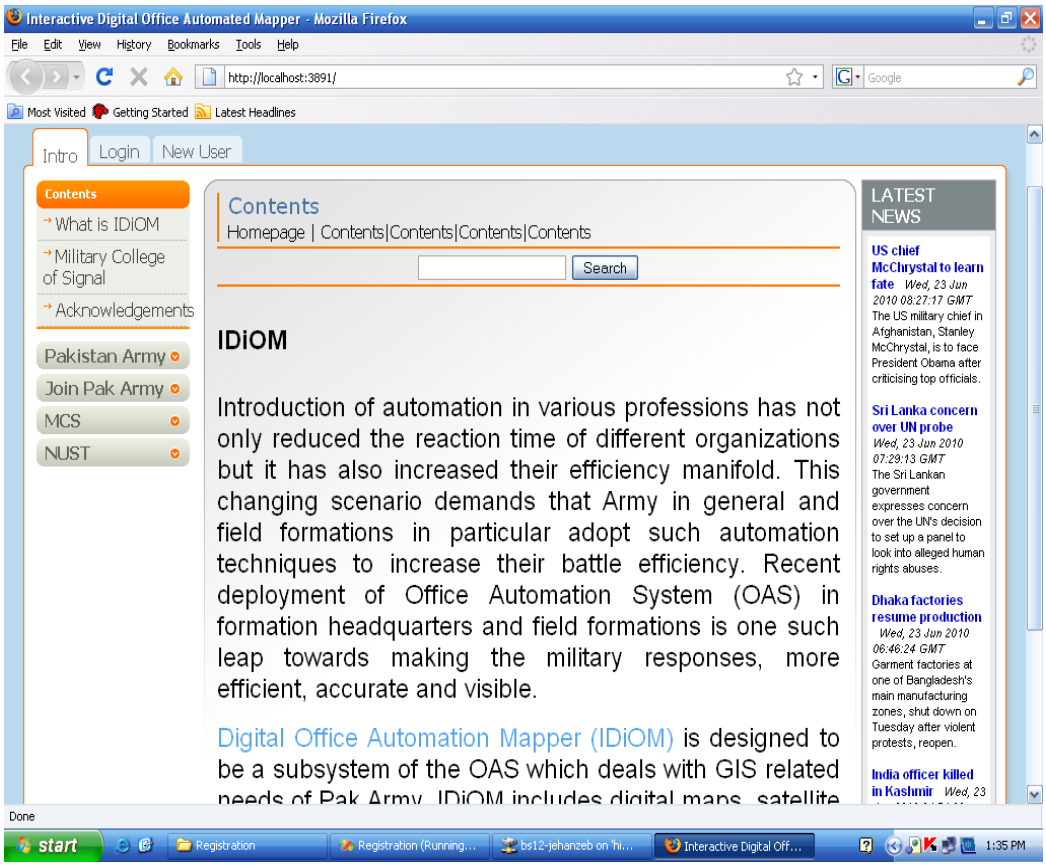

Figure 3.1: GUI

3.7 Performance Requirements

The requirements related to the performance of the system are performance requirements of the system.

3.7.1 Speed

The application is to be used for military planning over a system with normal specifications. Therefore system should provide the user with quick responses when displaying maps of a selected region.

3.7.2 Memory

The system would be using data of whole Pakistan and its surrounding areas and satellite images are very heavy, so system with greater memory is required at server side.

3.8 Non-functional Requirements

A non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors. This should be contrasted with functional requirements that define specific behavior or functions.

3.8.1 Security

The system should be secure because the data being used by IDiOM is classified. The security is also involved in the distribution of system. The data is made secure by specifying user rights and making data available only for registered users.

3.8.2 Reliability

The system is to be used by the field commanders for military planning. So the system's reliability is important for working and availability. It should be reliable enough to work well on the user inputs. Its reliability is most important in case of its output. Output is IDiOM is the plan which is to be executed against enemies. Wrong output may result into the failure of a military operation. It is required and expected to be available to the user all the time. Any chances of unavailability and malfunctioning should be minimized.

3.8.3 Maintainability

The IDiOM data changes with time. Therefore, the system should be an easy-to-maintain one. System should be able to incorporate any changes in the data. The system should be maintainable so that in case of any complaints from the users, the system should be modified to meet the new requirements.

3.8.4 Portability

The system need to be portable because it has to be deployed at all army formations.

3.8.5 Compatibility

The system will be made portable enough that any system with Microsoft Windows installed will be able to access the system's features.

3.9 Summary

The IDiOM is required display the map of any given region. It should allow the user to make military plans and export them to different field formations if required. Since, GIS tasks are complex in nature; the best utilization can only be made if they are simplified for the army field commanders. So, the IDiOM is required to be user friendly for the user's ease to use it.

CHAPTER 4

SYSTEM DESIGN

4.1 Introduction

System design is a very important phase in the software development process. The succeeding implementation phase is performed taking into consideration the design constraints. The software design of a program or computing system is the structure or structures of the system, which comprise software components/modules, the externally visible properties of those components/modules, and the relationships between them. This chapter covers the layout of our project. The components designed and their link with each other is explained here in detail.

4.2 High Level Design

The high level design focuses on the main modules of the system and not considering their inner details. The Figure 4-1 identifies the fundamental modules of the project. It can be depicted from the figure that the system is basically integration of different tools. We will explain each of these modules one by one.

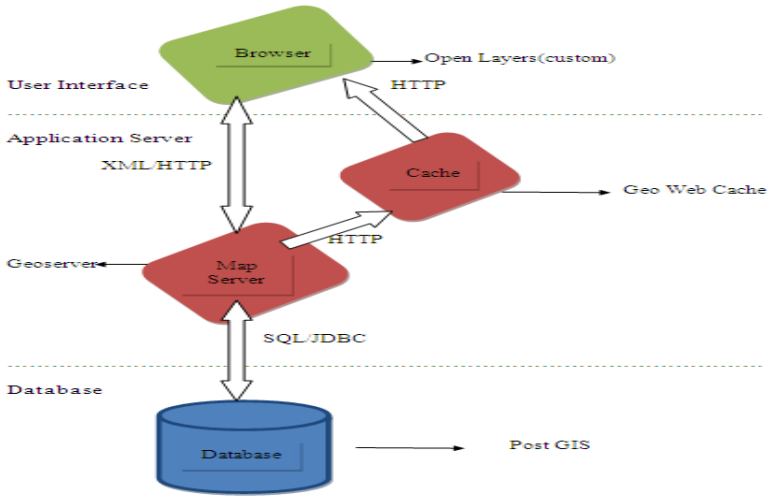

Figure 4.1 System High Level Design

4.3 System Overview

The system is developed keeping in mind the following design as shown in figure 4.2

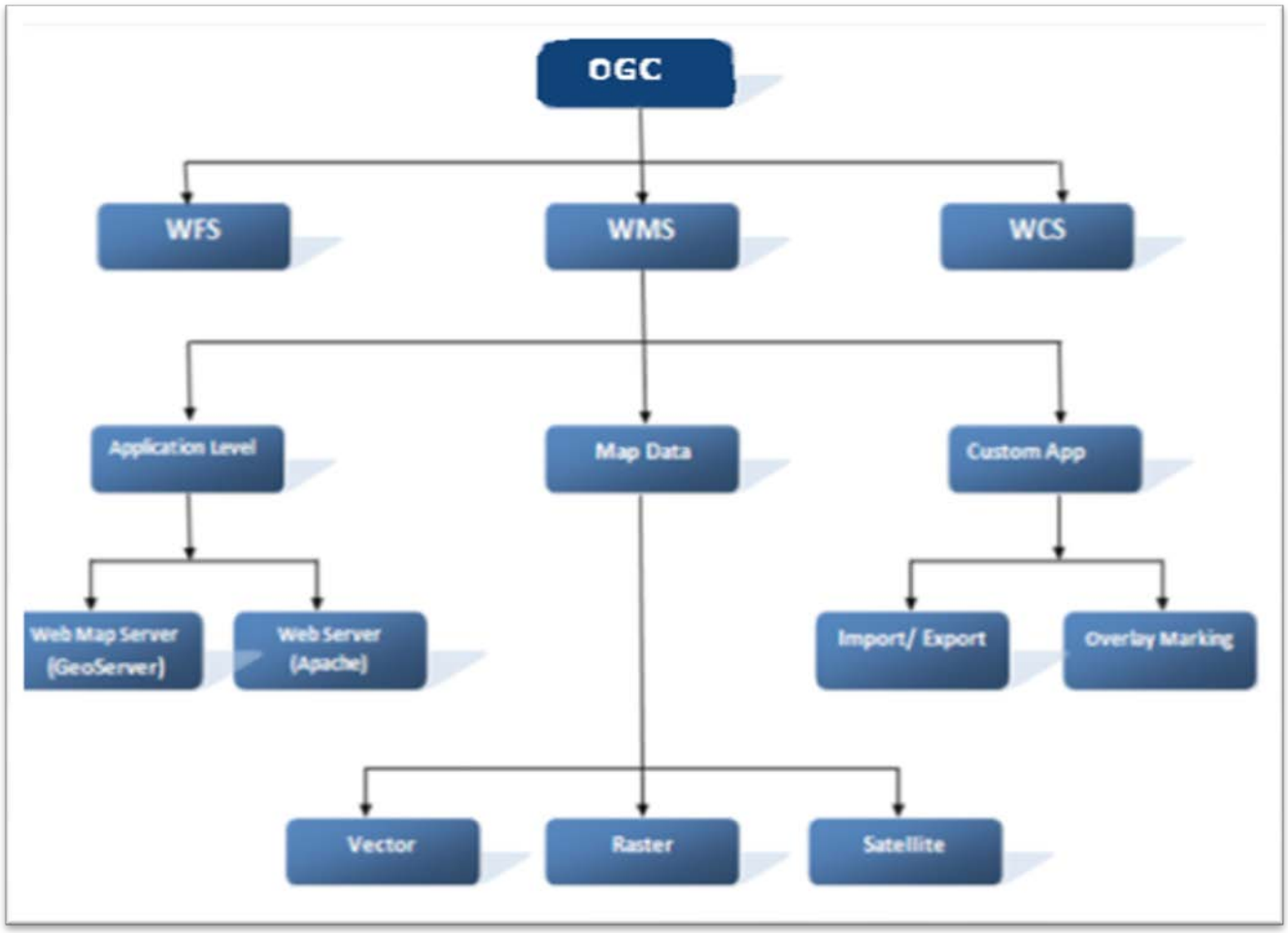

Figure 4.2 System Overview

4.4 System Architecture

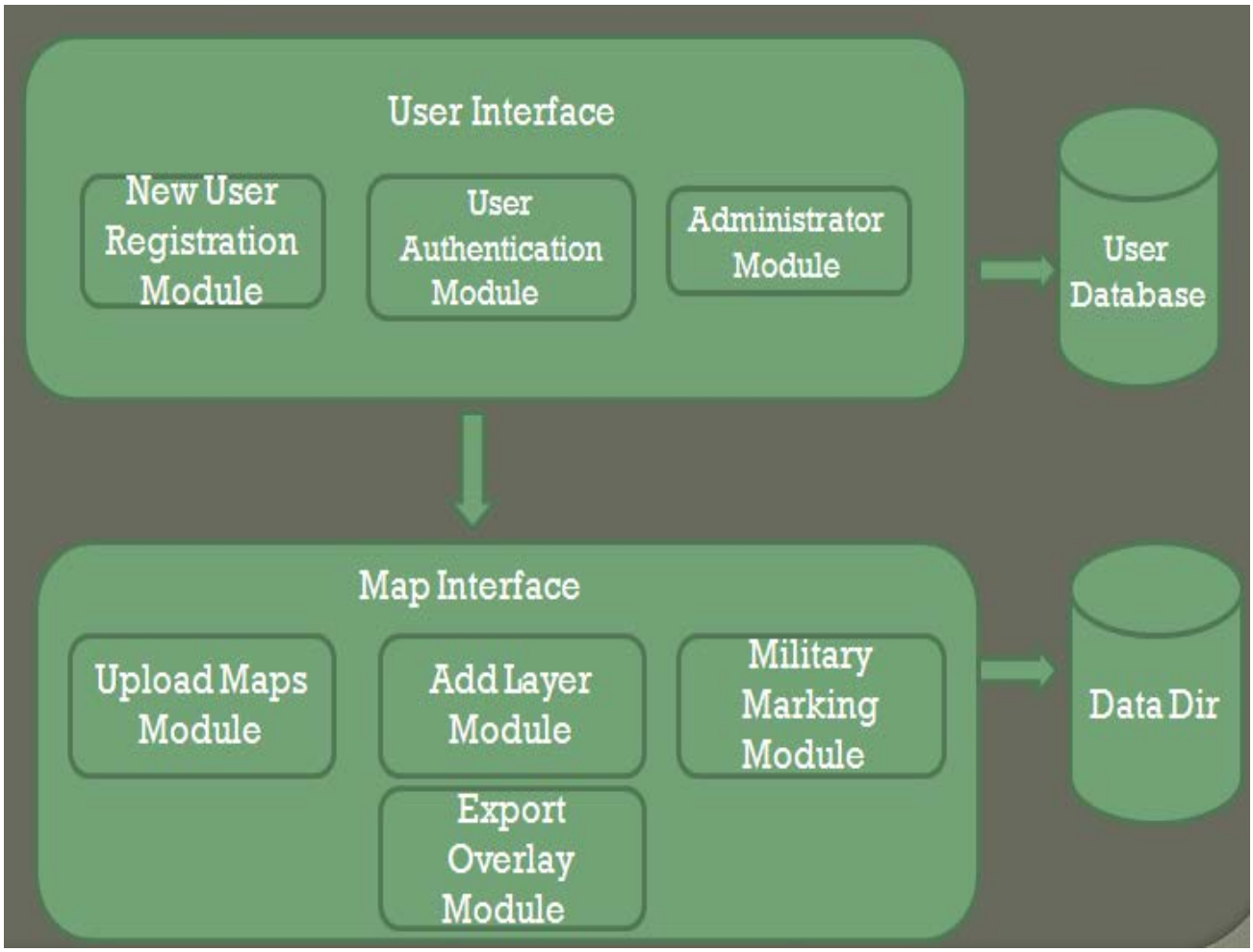

Fig 4.3 System Architecture

4.5 Low Level Design

The following diagrams represent the low level design of project.

4.5.1 Use Case Diagram

The use case diagram of the system has been given below. This diagram describes the interaction of user and the system

.

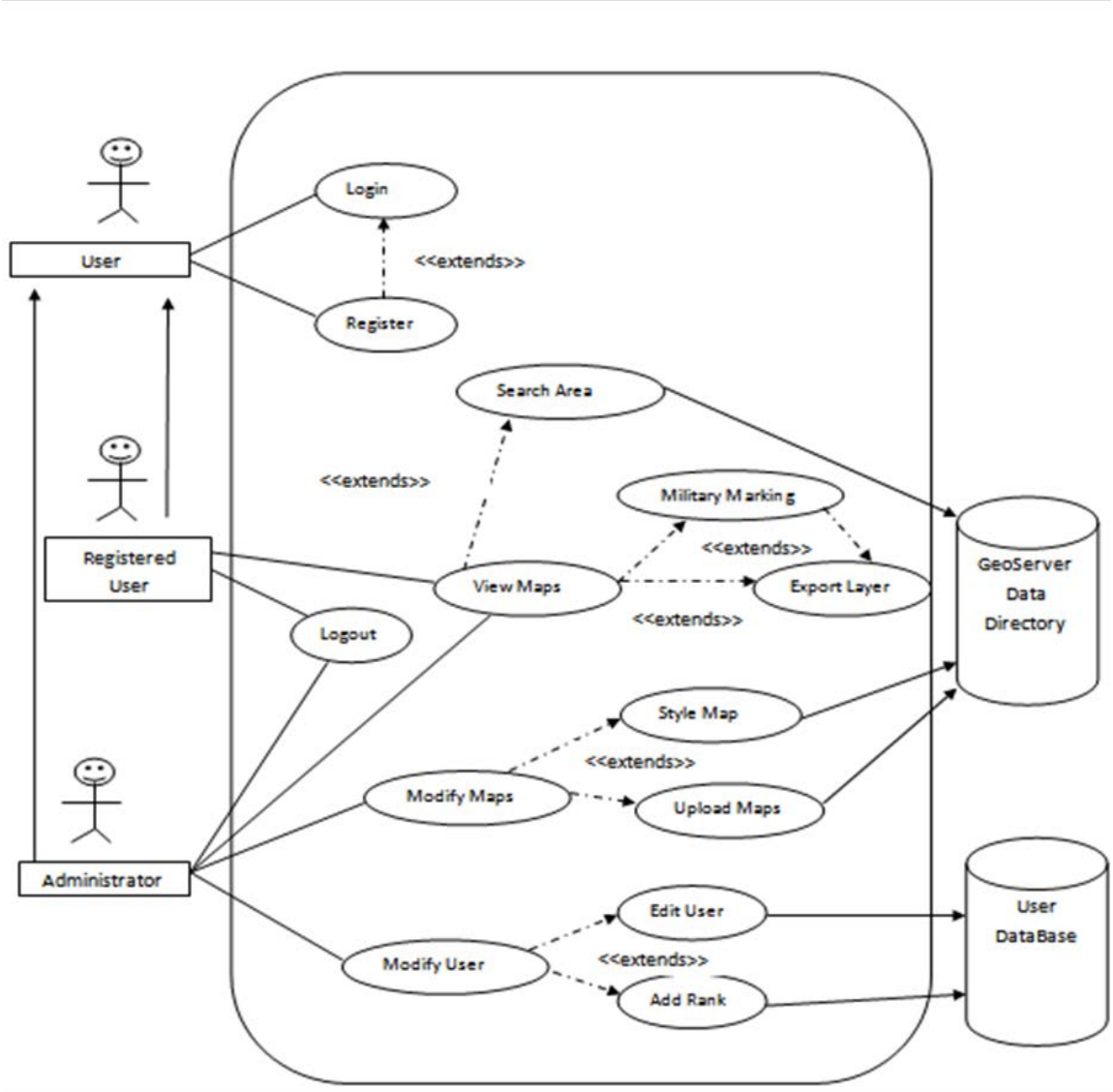

Fig 4.4 Use Case Diagram

4.5.1.1 Basic Flow of System

User registers him into the system. The administrator verifies the user. Now the user can view the maps and can make changes in it. The can also make the plans over these maps and save them on his system and export them to other users. The user can view different types of maps by selecting the map type. The authorized users can make changes in the system database as

well as in map database. The administrator can change the role of the user and he can also cancel the registration of a user.

4.5.1.2 Post Conditions:

System has performed the action which was requested by user i.e. view maps, make military plans etc.

4.5.1.3 Alternate Scenarios:

There is no alternate scenario because the objective is defined and application has been developed by strictly following the requirements.

4.5.2 Sequence Diagram – Login Page

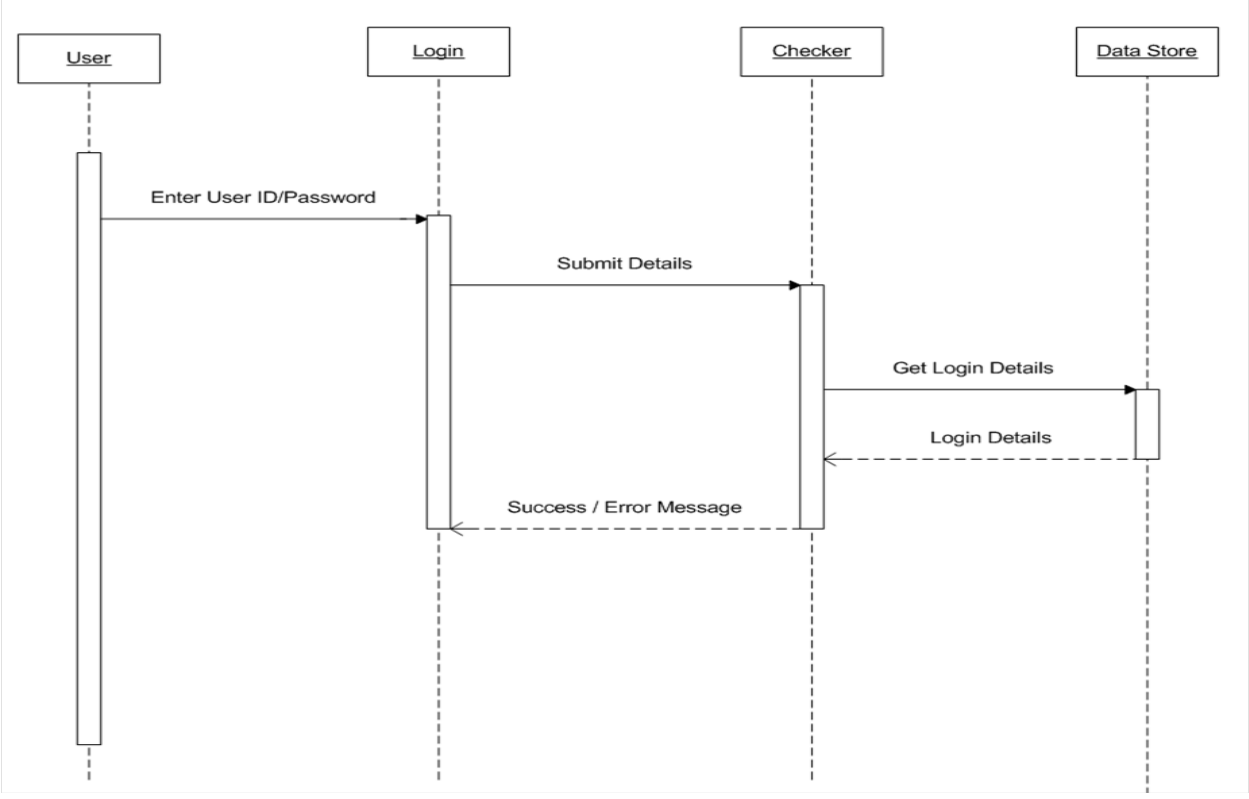

Fig 4.5 Sequence Diagram – Login Page

4.5.3 Sequence Diagram – Map Manipulation Page

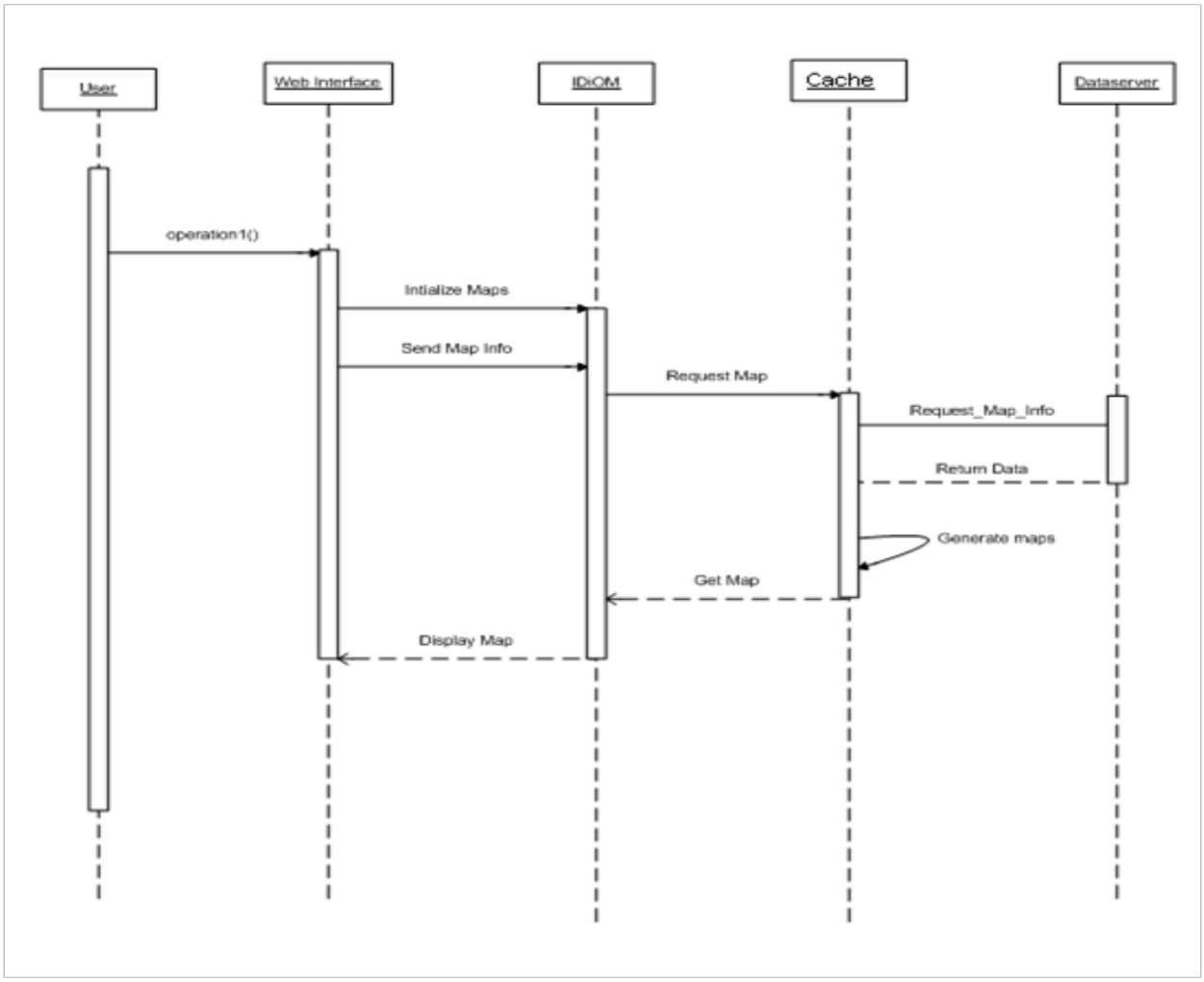

Fig 4.6 Sequence Diagram – Map Manipulation Page

4.5.4 System Presentation Model – Home Page

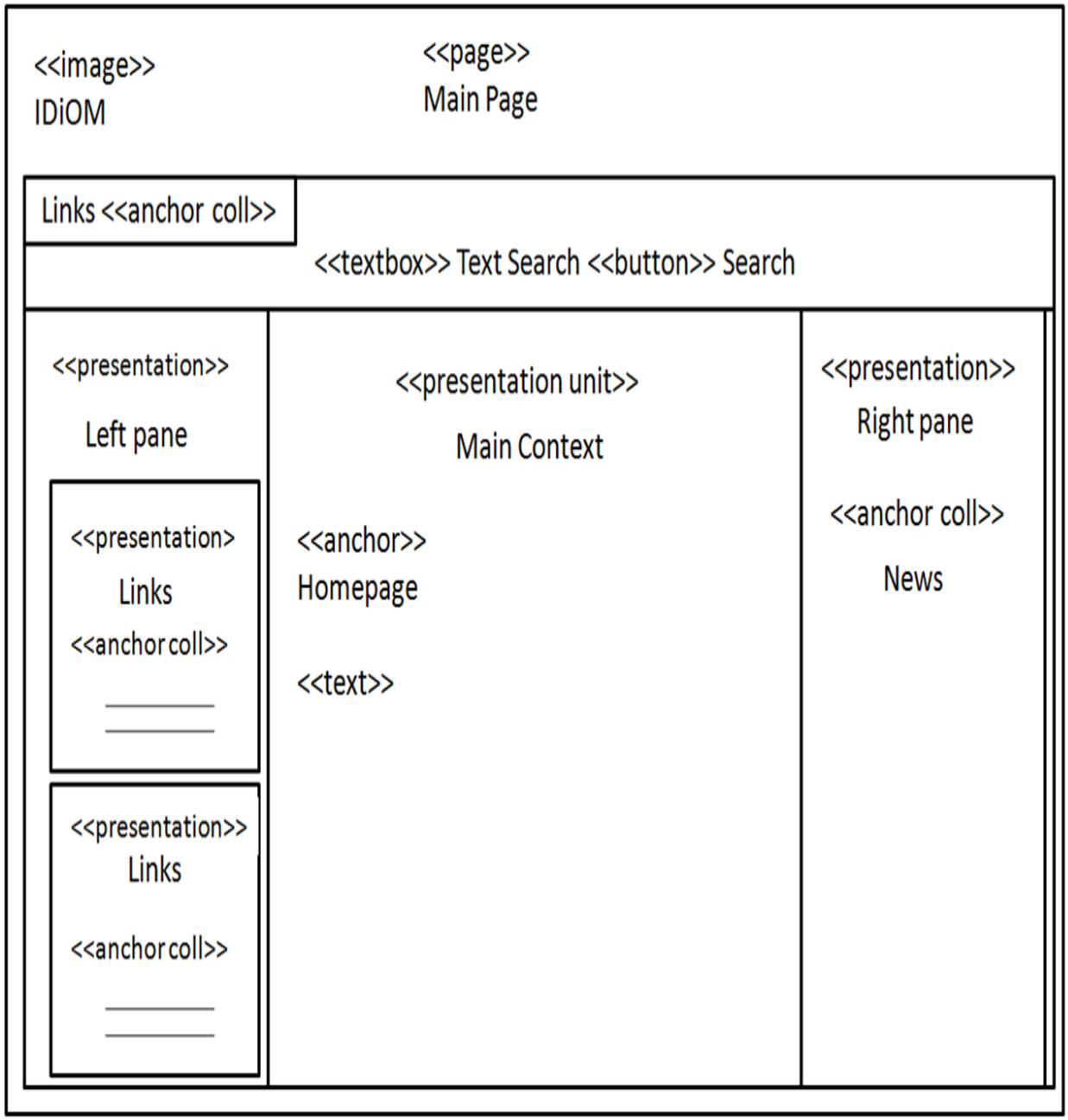

Fig 4.7 System Presentation Model – Home Page

4.5.5 System Presentation Model – Map Manipulation Page

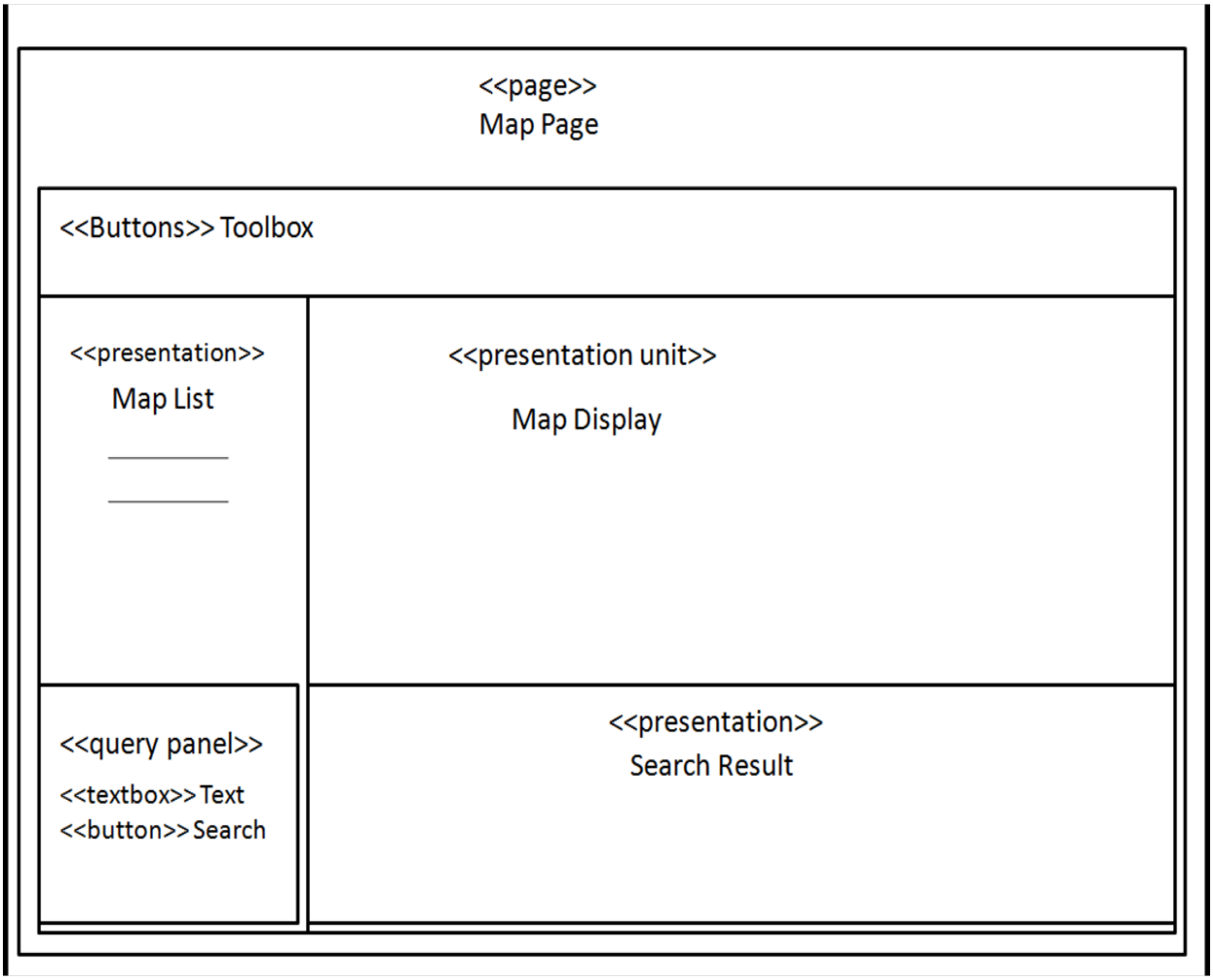

Fig 4.8 System Presentation Model – Map Manipulation Page

4.6 Modules

4.6.1 Application Level Design

It comprises of two main modules.

1. Web Map Server (GeoServer)
2. Web Server (Apache)

4.6.1.1 Web Map Server (GeoServer)

The WMS being used in our application is GeoServer. It is an open source web server written in Java that allows users to share and edit geospatial data. Designed for interoperability, it publishes data from any major spatial data source using open standards. GeoServer is the reference implementation of the Open Geospatial Consortium(OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high performance certified compliant Web Map Service(WMS). GeoServer forms a core component of the Geospatial Web. As per user requirement GeoServer was selected as a Web Map Server for our project.

GeoServer is being used for uploading of map data. It supports vector as well as raster data. Raster data is guide map, which shows the different areas. The vector data is in the form of shapefiles. The shapefiles can be placed over raster maps to view the different networks. e.g. Roads, Railway, Water network. The shapefiles contain the information of all the data. e.g. the shape file of roads network consists of all the information regarding roads, their name, length, type etc. the application also provides the facility to add new roads in the shapefiles or to change the existing one.

4.6.1.2 Web Server (Apache)

In our system we have used Apache Server, as known well it's a web server software notable for playing a key role in the initial growth of the World Wide Web. It became the first web server software to surpass the 100 million web site milestone. Apache was the first viable alternative to the Netscape Communications Corporation web server (currently known as Oracle iPlanet Web Server), and has since evolved to rival other Unix-based web servers in terms of functionality and performance. The majority of web servers using Apache run a Unix-like operating system. The application is available for a wide variety of operating systems, including Unix, GNU, FreeBSD, Linux, Solaris, Novell NetWare, Mac OS X, Microsoft Windows, OS/2, TPF, and eComStation. Apache is characterized as open source software.

4.6.2 Web Application Interface

The interface of the web application has been kept simple so that a user with average expertise in computer can also use this application for military planning which was the key requirement of our client. Furthermore the data being used by the application is classified so the security was another main issue in our application. The application consists of different pages and a user can access these pages only if he is having sufficient rights. The web application consists of three types of users.

1. Unspecified
2. Registered User
3. Administrator

4.6.2.1 Unspecified

Initially when a new user registers himself, he is given the role of unspecified. The user can't view maps or perform any other activity till the time his data is verified by the administrator. The administrator will

then assign him the role according to the requirements.

4.6.2.2 User

This is the role assigned to a user when his data is verified by the administrator. This role is assigned to a normal regular user. The user has rights to view the maps, their data, and can make military plans over maps and he can save these plans. He can also import/export military plans and use them according to the requirements. The user doesn't have rights to make changes in the map database. He can't add or delete maps from the database.

4.6.2.3 Administrator

This is the role assigned only to authorized users. There can be more than one administrators depending upon the conditions. e.g. in a unit the administrator role can be assigned to both CO and 2IC. The administrator is having all the rights. He can add or delete the maps from database. He can also update the existing maps in database. The administrator is having all the rights to cancel the registration of some existing user or to change his role.

4.6.3 Map Data

The maps being used in our application are of three types.

1. Vector
2. Raster

3. Satellite

4.6.3.1 Vector Maps

Vector maps deals with discrete phenomena, each of which is conceived of as a feature. The spatial characteristics of a discrete real world phenomenon are represented by a set of one or more geometric primitives (points, curves, surfaces, or solids). Other characteristics of the phenomenon are recorded as feature attributes. Usually, a single feature is associated with a single set of attribute values. The vector data is in the form of shapefiles. The shapefiles can be placed over raster maps to view the different networks. e.g. Roads, Railway, Water network. The shapefiles contain the information of all the data. e.g. the shape file of roads network consists of all the information regarding roads, their name, length, type etc. the application also provides the facility to add new roads in the shapefiles or to change the existing one.

4.6.3.2 Raster Maps

Raster data deals with real world phenomena that vary continuously over space. It contains a set of values, each associated with one of the elements in a regular array of points or cells. It is usually associated with a method for interpolating values at spatial positions between the points or within the cells. . Raster data is guide map, which shows the different areas. The shapefiles can be placed over raster maps to show the road/water/railway networks of different areas.

4.6.3.3 Satellite Imagery

Satellite imagery consists of photographs of Earth or other planets made by means of artificial satellites. In our application we are using satellite imagery as our base image. The shapefiles of different networks are placed over base layer to view the information of different areas. The base layer provides a platform where we can see the satellite photograph of some area. The placement of shapefiles over the layer gives us a useful information. Separately both of them cant give any useful information.

4.6.4 Custom Application

Despite using various tools for developing the application, yet all the client requirements were not being fulfilled, this required the development of some custom applications which are described ahead.

1. Searching map/satellite imagery of an area.
2. Overlay Marking
3. Import/Export of overlay file.

4.6.4.1 Overlay Marking

The basic requirement of the client was to make the military plans on his computer instead of using large paraphernalia of a military operations room. The user can do the same on computer now as he could do on paper previously. IDiOM fulfills all the requirements of a user to draw military overlays.

4.6.4.2 Military Symbols

The military symbols are required to show the different field formations in Army i.e units, brigades, division, corps etc and different military entities. The user can draw military symbols to make a military

plan to be executed over the maps.

4.6.4.3 Drawing Military Plans

The application allows free hand drawing to user. The user can make the military plan over the computer as easily as he was doing before by hand.

4.6.5 Import/Export

The application allows the user to import already made military plans by higher officials to be carried out. Similarly a user can make his own plans and export them to other registered users to show. Harris Sets are used in Pakistan Army for communication of data during war time which has limitation of bandwidth i.e. 200Kb/s, so the overlays created for import/export are of small size and can easily be transmitted in this scenario. Figure 4.2 shows data communication using Harris sets

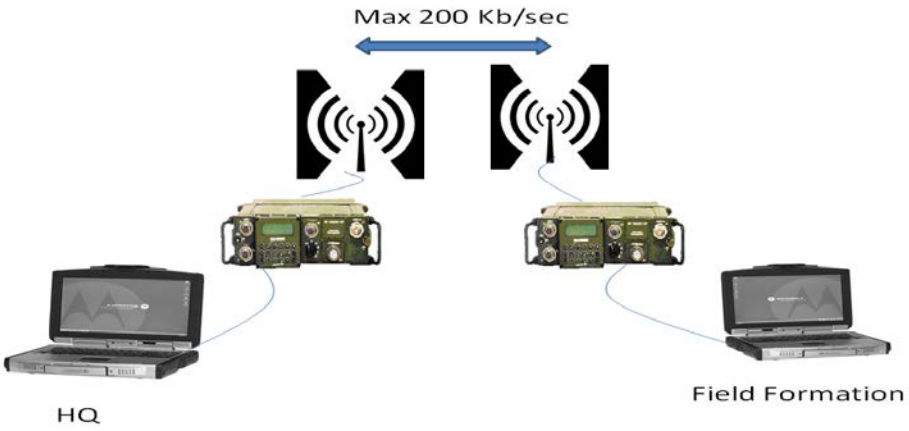

Figure 4.9 War time Scenario

CHAPTER 5

IMPLEMENTATION

5.1 Introduction

The application consists of two main parts i.e. front end and back end. Both of these have been implemented separately and are explained below.

5.2 Front end

The front end of the application has been developed in C#, ASP.net and html. The data base attached to the application is in SQL Server. The figure below shows the main page of IDiOM.

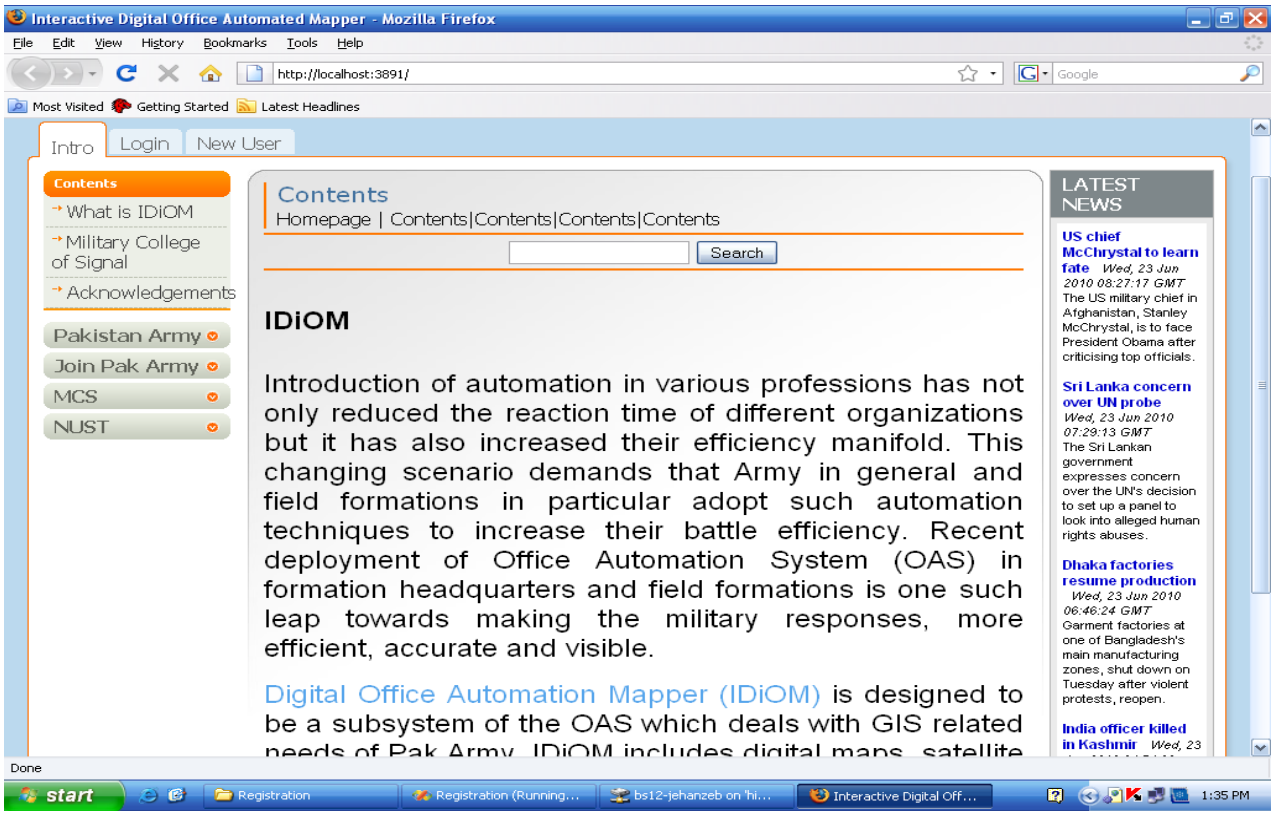

Figure 5.1- Home page

The user needs to get registered before making the military plan or simply to view the map of an certain area .The PA number of the user is set as primary key as it is unique number allotted in Pakistan Army to an Officer. A random person cannot register himself with PA number and start using the IDiOM , until administrator has verified the personal information of the individual and if verified authentic allotted the specified rights to an individual.

There are no restriction on password type, it can have alphabets, numbers, special characters or combination of all these but keeping in mind the security issues password of the user has been encrypted by using built in MD5 function to keep the user password save .The administrator is also not given the authority to view the user's password.

The following figure shows the registration page.

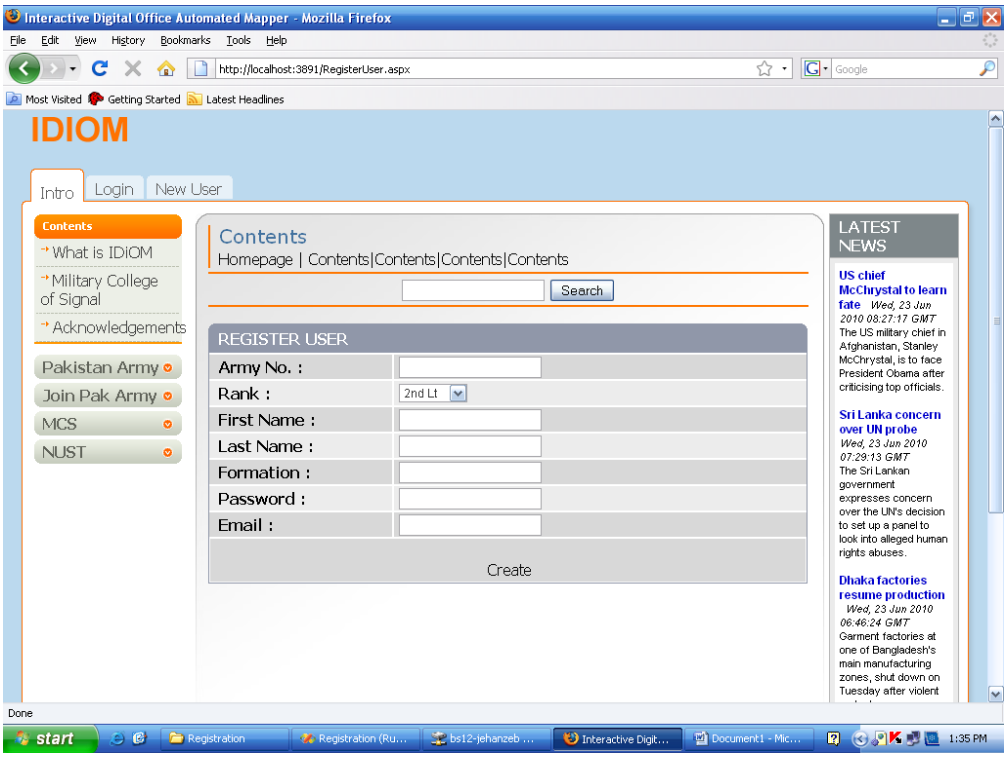

Figure 5.2- Registration page

Certain rights have been given to different type of users. Only the administrator has the authority to allocate user rights or user category, upload a new maps depending upon user's request and all other functionalities what a normal user is able to perform.

Whereas the registered user is allowed to view map or plan a on a map and also import or export overlays in the form of scalable vector graphic format (SVG) on the maps already uploaded on the server.

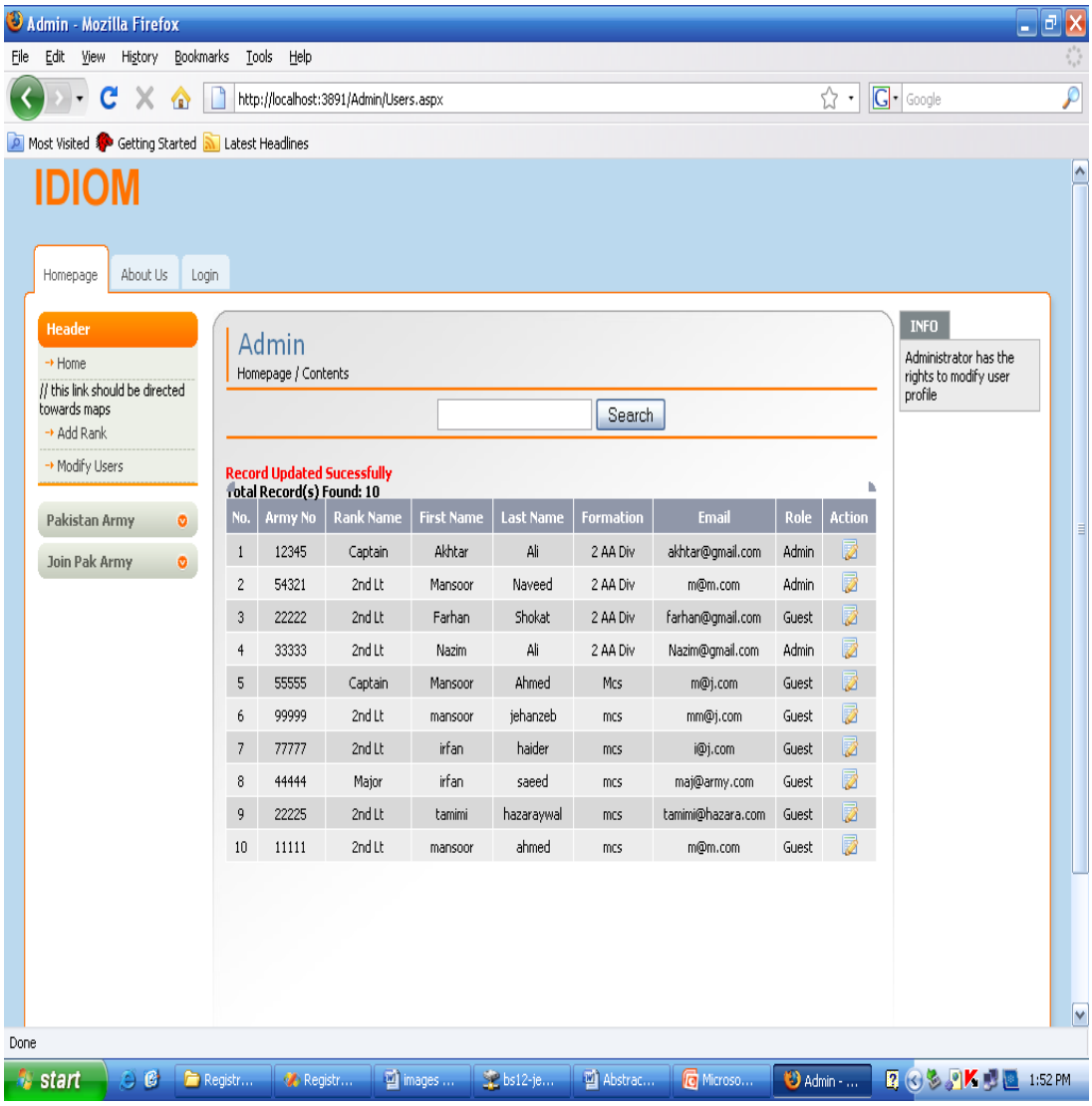

Figure 5.3- Admin page

Following figure shows the map page and a plan over it which is made by a registered user and the user is provided by military symbols which he can use which will facilitate in his military planning.

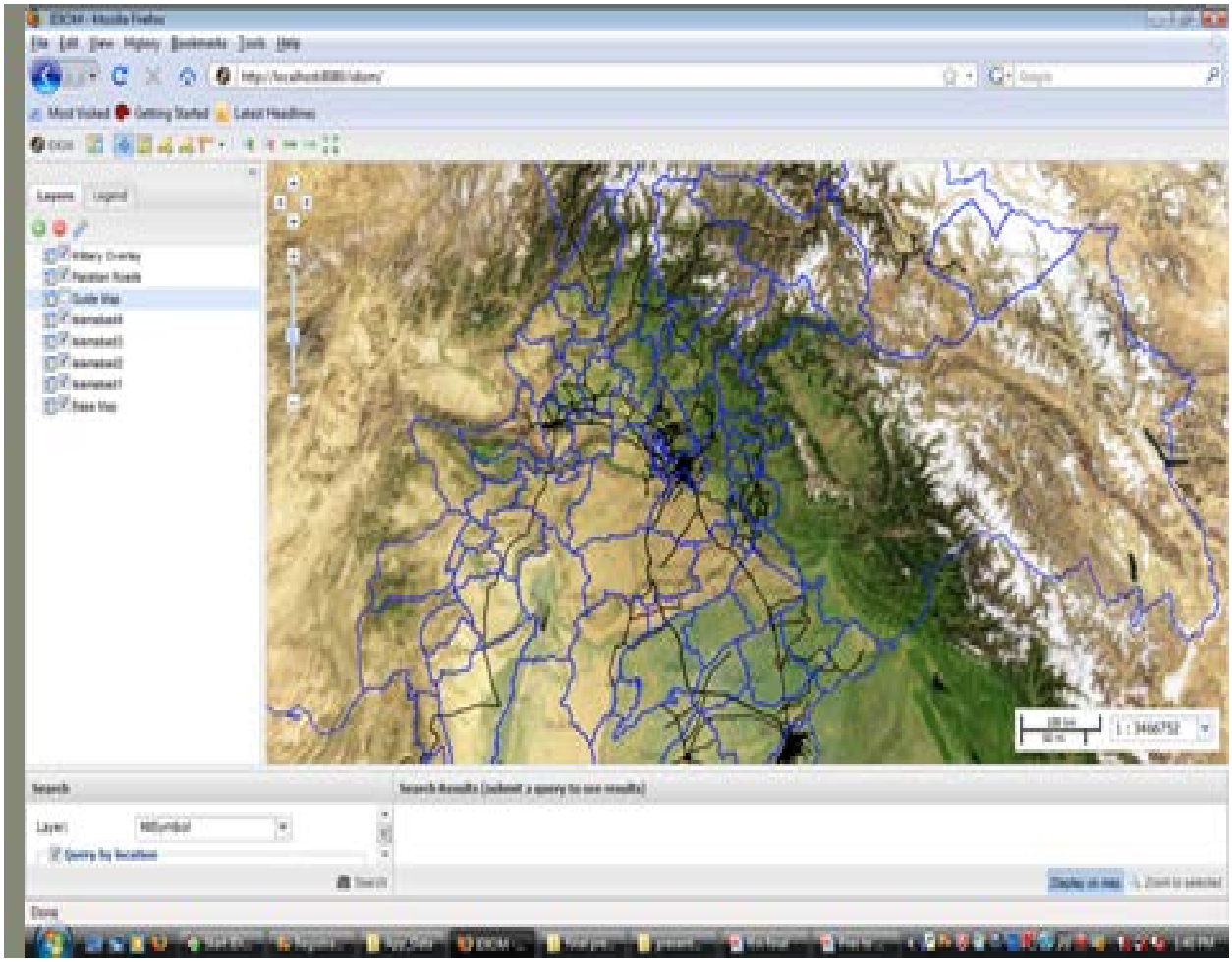

Figure 5.4 – Map display page

5.3 Backend

The backend of the application has been developed jointly using GeoServer and Openlayers. The GeoServer the web map server which supports both vector and raster data. In the application the raster data/ satellite imagery has been used as base layer and vector data as overlays. The combination of both these a=makes a map illustrative. The different layers have been integrated to form a single layer. The following figures show how different layers are combined to a single map.

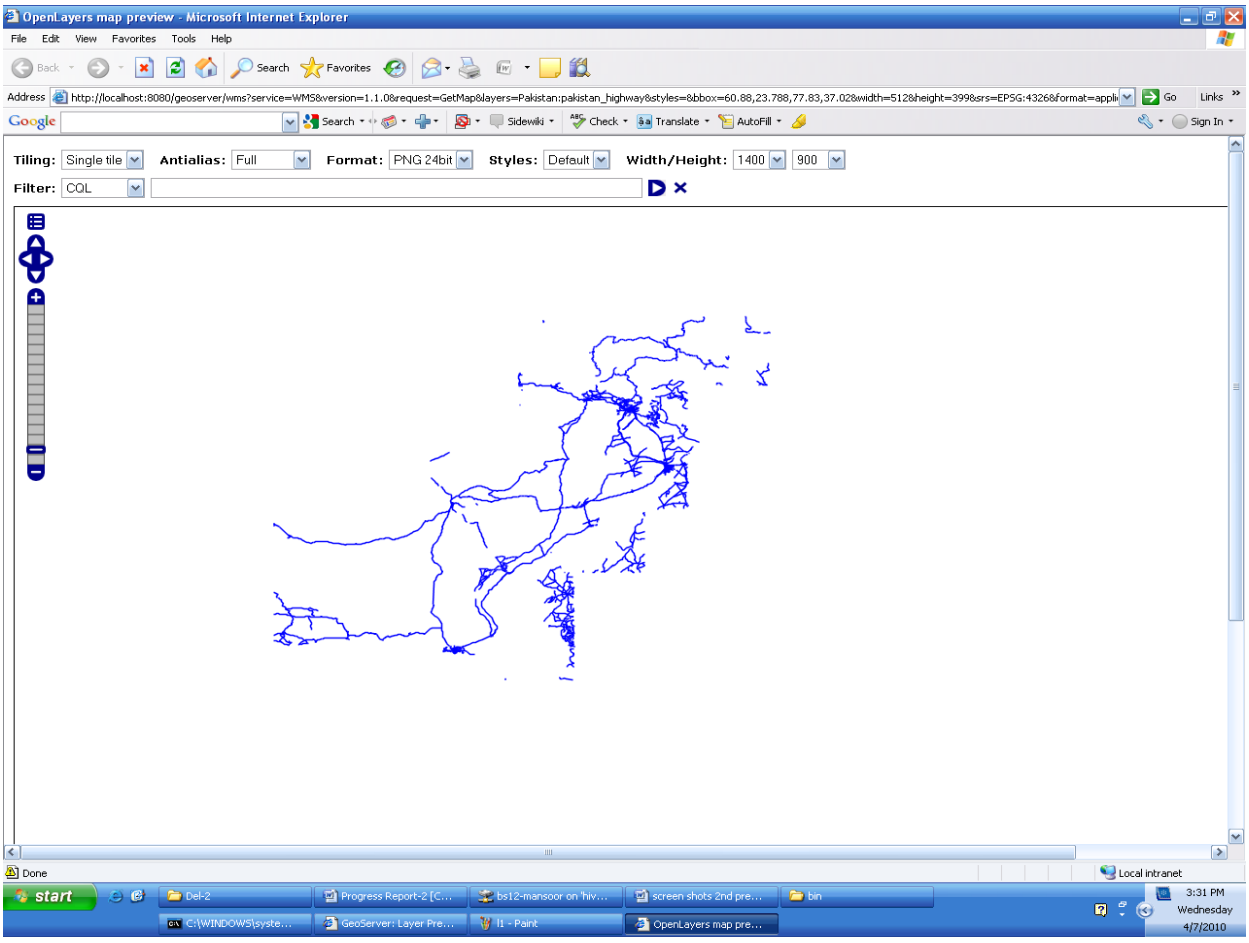

Figure 5.5 - layer 1

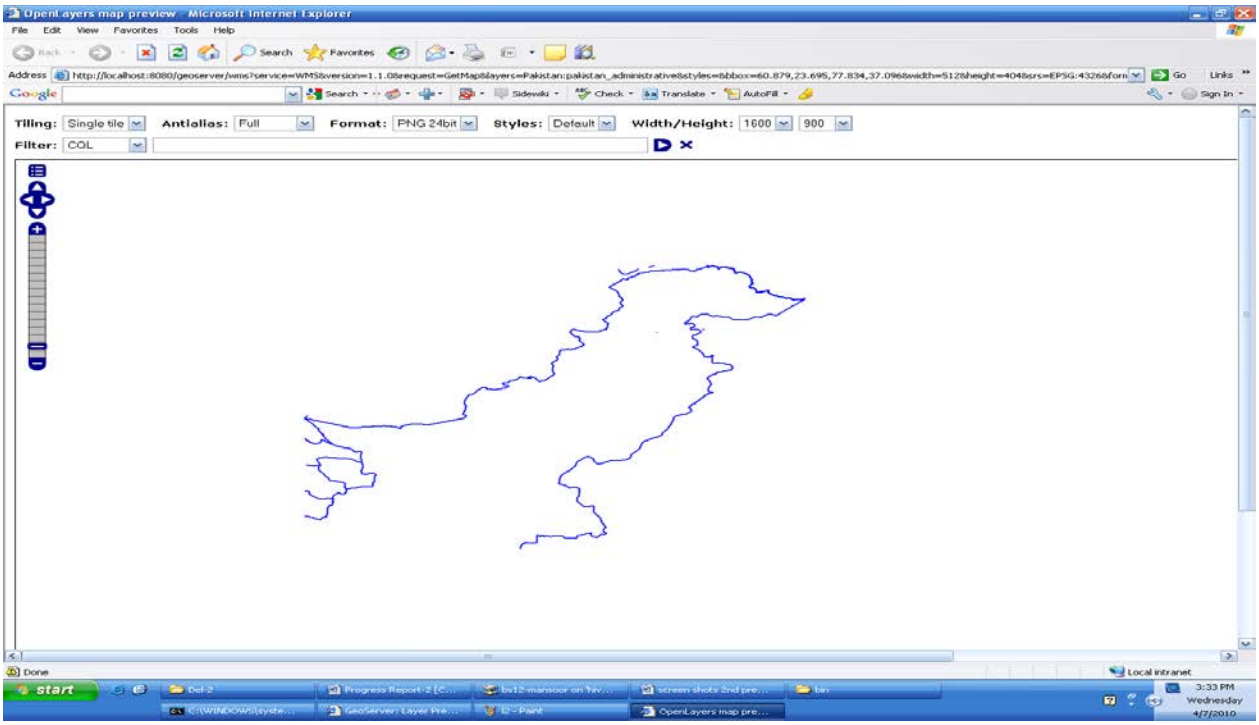

Figure 5.6 - layer 2

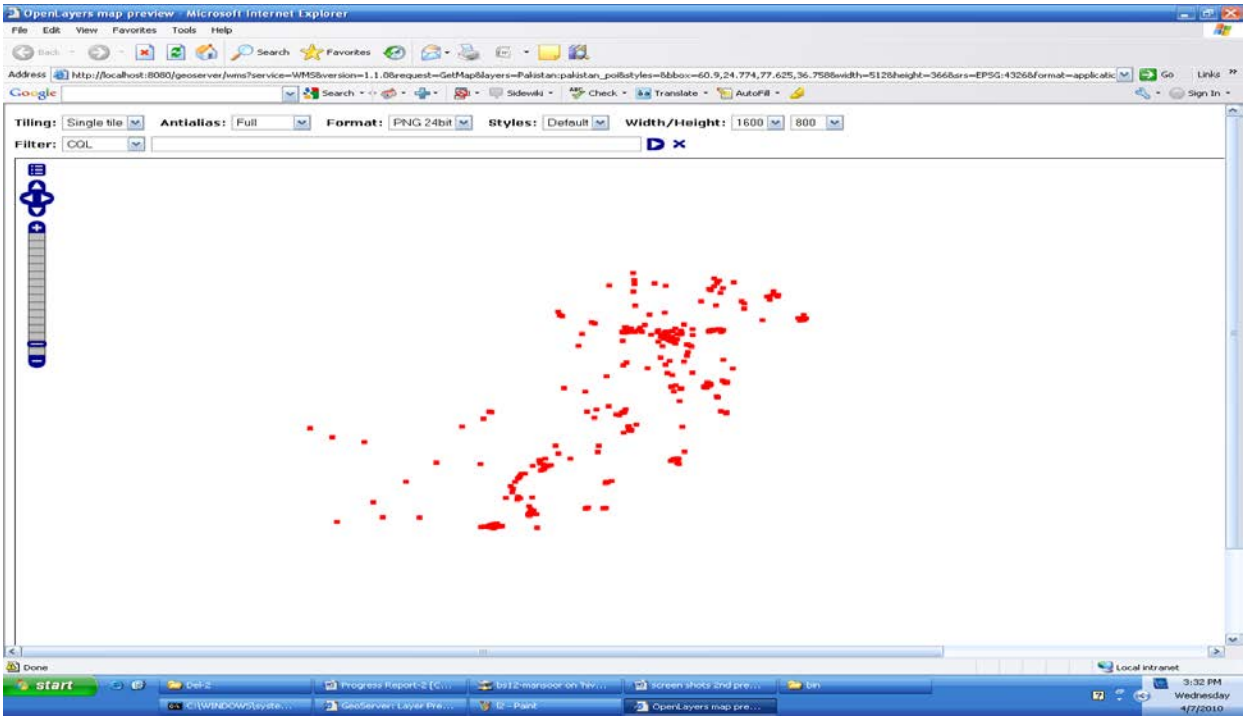

Figure 5.7 - layer 3

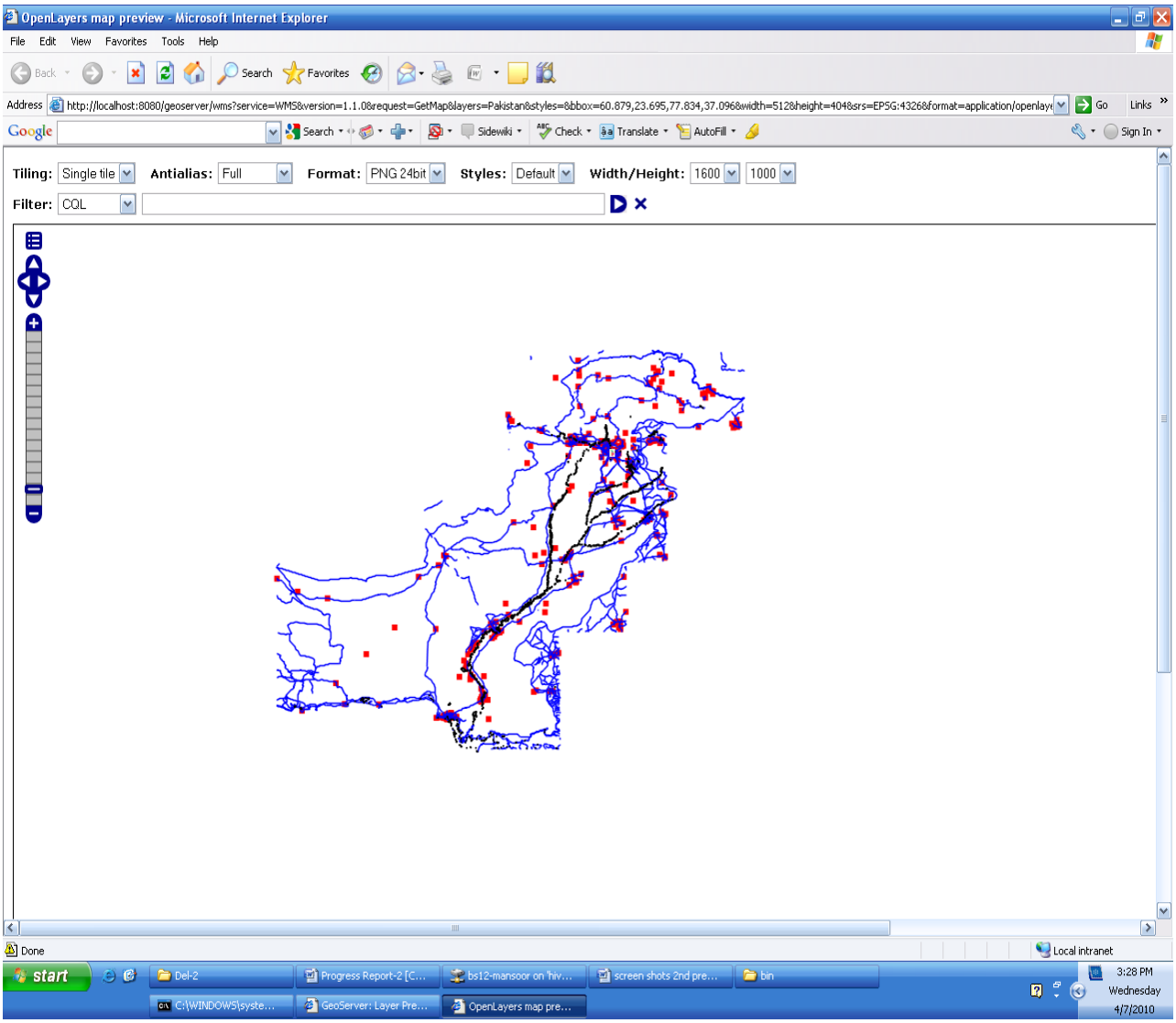

Figure 5.8 – Integrated Layer

The vector layers are placed over satellite imagery to view different networks e.g. read, railway etc. after the military plans are made and exported. Following figure shows the map and a military plan over it.

Figure 5.9 – Military plan over map

CHAPTER 6

SYSTEM TESTING AND VALIDATION

6.1 Introduction

Software testing is one of the most crucial phases of software development life-cycle. This can be termed as an element of a broader topic that is referred to as 'Verification and Validation' (V&V). Verification refers to the set of activities that ensure that software correctly implements a specific function. Validation refers to the different set of activities that ensures that the software that has been built is traceable to customer requirements.

6.2 Validation and Verification

Validation and verification is intended to be a systematic and technical evaluation of the system and its processes. To effectively deal with the increased complexity and functionality, systems need practical techniques that can help improve software quality using the validation and verification process.

IDiOM was tested for validation by giving it different inputs and getting the desired outputs. User cannot provide uncertain inputs because certain constraints have been imposed on each field. In verification testing it was assured that software meets all functional, behavioral, and performance requirements.

6.3 Unit Testing

In computer programming, unit testing is a procedure to validate that individual units of source code are working properly. A unit is the smallest testable part of an application. Unit testing concentrates on each unit of the software as implemented in source code. The goal of unit testing is to isolate each part of the program and show that the individual parts are correct. In our system each module as developed is individually tested. The each function performed on the map is tested such as zoom, fit, pan, view legend, view layers etc. Each operation and function is individually tested so as to check for possible errors that could occur.

6.4 Integration Testing

Integration testing is the phase of software testing in which individual software modules are combined and tested as a group. It follows unit testing and precedes system testing. In integration testing focus is on design and the construction of software architecture. All the modules have been combined and tested to ensure that they work according to the user requirements.

6.5 System Testing

In software testing phase overall system is tested as a whole. System testing of software or hardware is testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. The purpose of integration testing is to detect any inconsistencies between the software units that are integrated together. System

testing is a more limiting type of testing; it seeks to detect defects within the system as a whole.

In IDiOM user has to login with user name and password. So there is no chance of unauthorized user login. He can only view the maps and make military planning over it.

6.6 Summary

The system is tested thoroughly. It behaves according to the user requirement. The user is not allowed to specify any wrong inputs because have been imposed over input. On entering the required inputs system behaves according to the user requirement and presents the desired results to the user.

CHAPTER 7

RESULTS & ANALYSIS

7.1 Introduction

Army had been using OCCS software which was developed in 1990 worth millions of dollars in the corporation of China but had failed so due to certain reasons.

IDiOM has been developed to be a web application which is to be incorporated in Pakistan Army Office Automation System to overcome its GIS related matter. Army required a software which would work both in peace time and war time scenario .As in peace time bandwidth was not an issue the main objective was to make a system which would facilitate Army in War and would be reliable and available for data transfer.

7.2 Results

IDiOM has been developed in a way to facilitate military users while marking military plan. The idea has been to facilitate the user by placing maps on a central web map sever and providing the user with certain military symbology to mark his plan .The milestone was project was to transfer military plan in war time scenario as bandwidth was main issue as the transfer rate is 200Kb/sec on Harris communication sets which are used in army for data transfer.

This milestone was achieved by creating a file of SVG format and then sending to other desired users through the network. The main concept was to send the plan overlay instead of sending the entire map. By doing this the user at the other end can just upload the current overlay over its default map which was provided by the map server , doing this the receiving user will able to view the plan of action to be carried out .

As the data transferred between military users during war will take place Harris communications sets the importance encryption and decryption has been catered in this way which will provide safety to the content and avoid it from falling into wrong hands

7.3 Analysis

The previously adopted GIS system named OCCS/PAMO is software which was developed in1997-98 by Chinese engineers for Pakistan Army. Although this software was accepted and appreciated but it has following shortcomings:

a. The software was developed about ten years back, it has become outdated as compared to technology available now a days. Like the software doesn't support NTF maps which are currently being populated in army map database. Army has to buy and maintain software FALCON VIEW from GEORGIA TECH. Specifically for NTF maps.

b. Although it contained a large number of functionalities but this has made the system so heavy that it is not easy to be used in operational environment.

c. The system is not user friendly as a user with average expertise cannot use it. Normally officers just use them to take print out of the maps and mark them with hand.

d. Mostly CDs which were provided to different formations have not been used even once.

7.3.1 Others Developed GIS Systems

Other map planning platforms were also developed in the meantime to overcome the short comings but fulfill the army requirements but now as the complete army is moving towards complete automation the already developed desktop applications were of no use as

portability was the main issue they were facing. Our client C4I required an application which had a thin foot print and could be accessible through anywhere. The following table shows the comparison between OCCS and IDiOM.

OCCS	IDiOM
Desktop Application	Web Application
Requires uploading of data in every system	Centralized database
Exports Overlay only in OCCS format	Exports in Shapefiles, TIFF
Exports only the top most layer of map	Exports any desired layer
Based on Geomedia 4.0 (obsolete technology)	Developed using GeoServer
Difficult to work on	Open source technology
Extensive training required	User friendly
Extensive training required	Simple to user

Table 7.1 - Comparison between OCCS and IDiOM

7.4 Summary

While developing IDiOM latest tools have been used to develop the web map server. Making it a web application, it is now made possible for the user to use the application anywhere where

army intranet is provided all it requires to run is a web browser no additional software or any special platform is required .Keeping in mind the potential users the web interface is kept simple providing all the basic functionalities so that a person with even a little knowledge of computer will be able to take the benefit of marking military plans over the internet.

CHAPTER 8

CONCLUSION AND FUTURE WORK

8.1 Achievements

Our project was initiated with the aim of enhancing the capability of Army office automation system. The system is presently using the maps in a way that officers only take print out of a map from a specific location and then he marks his plan on it. Whereas the system not only enables the user to search the map of an area but also to use satellite imagery and enables the user mark military plans on it. The marked plan in the form of an overlay file can be exported to other end on Harris communication set in war/training scenario and army network in peacetime.

The project will increase Pakistan Army capability significantly by allowing the system to use any type of map and satellite imagery already updated or which can be uploaded at the server on user's request.

Working with growing organization C4I Directorate and Digital Mapping Unit was a great learning experience for us. This helped us to learn GIS based software GeoServer that is being using throughout the world and working in OpenLayers.

Our project is planned to be presented to higher officials of Digital Mapping Unit, R&DE NUST and C4I Directorate GHQ.

8.2 Industrial and Commercial Use

This project can be used for finding the area of interest (AOI) of commercial clients. The project gives detail of each selected area. The details include map of higher resolution, satellite imagery and any vector data available. This can be used for maintaining the record of complete Pakistan for agriculture and industrial use. This can be automated for finding an area by district, city and village information of that area.

8.3 Future Work

This project can be further extended as a distributed application where the geographical data will be kept at central location and users can access it remotely which will not only make it easier to update the databases involved but also give the user a freedom to carry and use it without much of processing power. Some areas where more enhancements can be pursued are indicated below:

8.3.1 Enhancement of Security

Enhancement of security of transferred geospatial maps, imageries and data since it will consist of highly classified plans which can be disastrous if compromised.

8.3.2 Incorporation of Deployed Forces Database

Incorporation of database of personnel's, equipment and vehicles by of already deployed forces can be done by populating the geospatial database using the framework as propose by our project.

8.3.3 Decision Support System

IDiOM capabilities can be enhanced my making a decision support system which will be able to help the commanders in making their military plans. The decision support system will be able to guide the military commander to use apply what course of action for a certain situation taking place or use what kind of weapons to tackle a threat .

8.3.4 Generalized GIS application

Although this system is mainly developed for Army but with some modifications and adding more custom application depending upon user requirement it can be converted to a generalized GIS application to be used in all fields of life like media, medical, urban and rural planning, etc.

8.3 Conclusion

Geographical Information System (GIS) is a widely accepted visualization tool that presents data in a graphic form, which is a convenient and effective means of communicating complex information.

IDiOM would have major effect on future battlefield planning. It is because the GIS have the capability to enable the capture of the battlefield plan and present the comprehensive picture in a simple manner to other in command . With the Development of Office Automation System, Pakistan Army is already abandoning previous manual systems and now as GIS mapping requirement of Pakistan Army has been met by IDiOM which can be incorporated in to already deployed OAS Army can completely be dependent on Office Automation System (OAS) for map related data .

CHAPTER 9

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