Saskatchewan Geospatial Imagery Collaborative

Basic User Guide

Version 1.0

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Introduction

The Saskatchewan Geospatial Imagery Collaborative

The Saskatchewan Geospatial Imagery Collaborative (SGIC) is a partnership of organizations sharing knowledge and costs relating to acquisition and use of remotely sensed imagery for mutual and public benefit. The collaborative operates servers providing a web mapping client and an OGC-standard Web Map Service (WMS) for sharing geospatial imagery. Members of the public are welcome to use a limited set of the SGIC's geospatial imagery holdings, while SGIC members gain access to an expanded set of imagery products.

What This Manual Covers

This manual covers basic usage of two interfaces to the SGIC's geospatial imagery products:

- The SGIC Web Mapping Client – a web browser-based interface for searching and viewing geospatial imagery; and,
- The SGIC Web Map Service – and OGC standards-compliant interface for requesting map images over the internet.

This manual applies to both free public access and to SGIC members-only access. It also has two appendices for further reading:

- Appendix A – Introduction to Geospatial Data; and,
- Appendix B – Introduction to SGIC Hardware / Software

Additional Documentation

Additional documentation is available to SGIC members and covers the following topics:

- Downloading images through the SGIC Web Mapping Client;
- Administering users through the SGIC Web Mapping Client; and,
- Administering data through the SGIC Web Mapping Client.

Chapter 1
Using the SGIC web mapping client

Introduction

The web mapping client provides a web browser-based interface for users of the SGIC's data. It provides all of the functionality needed to add data to a map image, view data, and download it to the user's computer.

Loading

The web mapping client is loaded by navigating a web browser to the URL http://www.flysask.ca. Either the public or secure member access buttons can be clicked. Note that depending on the user's security settings in their web browser, they may receive a message the when the site is loaded. It is possible to avoid these messages by adding the domain http:www.flysask.ca to the browser's trusted hosts list.

Note that because of the web mapping client application's use of OGC Web Services to obtain its data, it is not possible to use the application without a network connection to the internet.

Application Components

A view of the SGIC web mapping client application as it appears once the user has loaded it is shown in Figure 9. The user interface is divided into three "panels;"

- Header Panel – the header panel, running across the top of the web browser, shows the name of the application. If the application was accessed through the secure member login, this pane also shows the user's name and provides a logout button to allow the user to end their session;

- Menu Panel – the menu panel, running across the left hand edge of the web browser, shows a menu of tools that the user can access to view and manipulate data. The menu panel works as a "stack panel." Meaning that the tab that is selected by the user will be scrolled into view; and,

- Map Panel – the map panel displays map data in a geographic projection. It also has controls for panning and zooming the map, and a key map control to provide a visual reference of the selected location.

The map panel is initialized to show the NASA "Blue Marble Next Generation" data set, along with a vector layer showing the provincial boundaries for Canada. The map is centred on Saskatchewan, and is zoomed out to the maximum scale of 1:25,000,000.

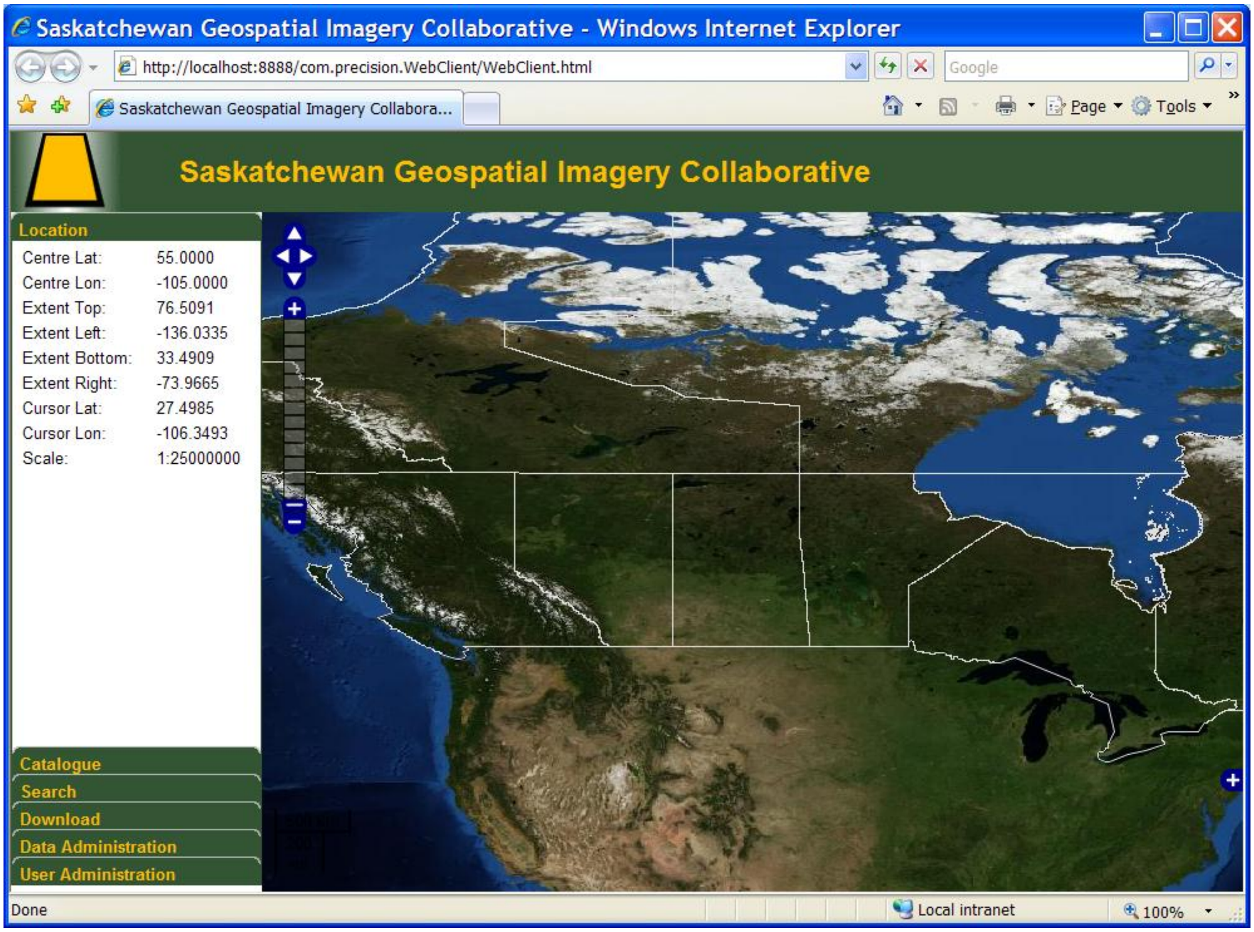

Figure 9. SGIC Web Mapping Client Application

Using the Map Panel

The map panel has three controls on it for viewing map data. In the top right corner, there is a control for panning the display – moving it up, down, to the left or to the right. Below it is a control for zooming the display. It supports the following map scales:

- 1:25,000,000
- 1:10,000,000
- 1:5,000,000
- 1:2,500,000
- 1:1,000,000
- 1,500:000
- 1:250,000
- 1:100,000
- 1:;50,000
- 1:25,000
- 1:10,000
- 1:5,000
- 1:1,000

In addition to using the pan and zoom controls, the application also supports directly panning and zooming the display using the mouse. Click on a portion of the map and hold the mouse button down while dragging to pan the display. To zoom the display, rotate the centre wheel on your mouse. It is also possible to select a specific zoom extent by holding down the shift key on your keyboard and dragging a rectangle over the feature in question. This operation is shown in Figure 10.

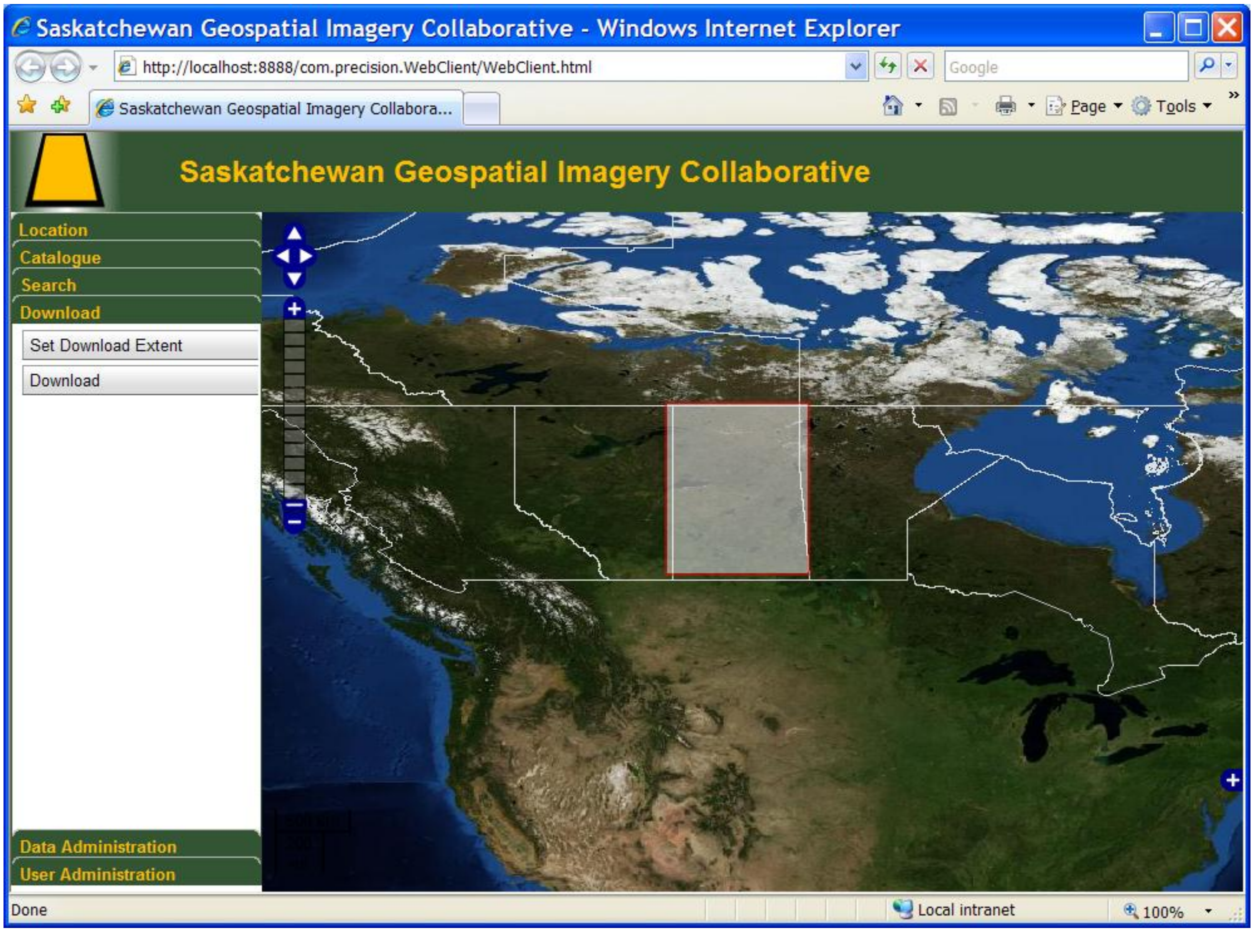

Figure 10. Zooming to a specific extent by holding down the shift key,

On the lower right side of the display, a key map window can be opened by clicking on the "+":control. The key map is useful for determining what the main map display is showing if it is zoomed in.

Using the Menu Panel

Four tools are provided on the menu panel to assist the user in viewing and manipulating geospatial data, and two tools are provided (in the secure member access version of the application) to assist administrators in manipulating data.

- Location Tool – the location tool provides the user with detailed information about what they are currently viewing in the map display. The location tool is shown in Figure 11.

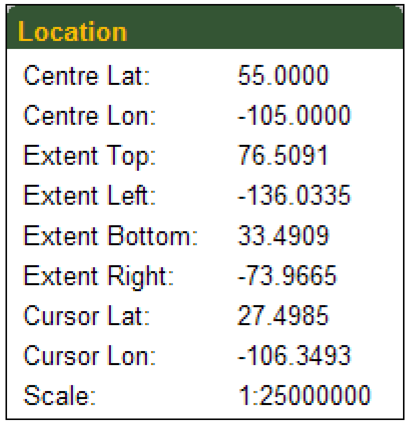

Figure 11. Location Tool Panel

- Catalogue Tool – the catalogue tool allows the user to select layers from the current map for display in the map window. Layers are added or removed by selecting the check box next to the layer name. Note that layers can be grouped into themes, and all layers in a theme can be added to the map display by selecting the check box next to the theme name. The catalogue tool panel is shown in Figure 12.

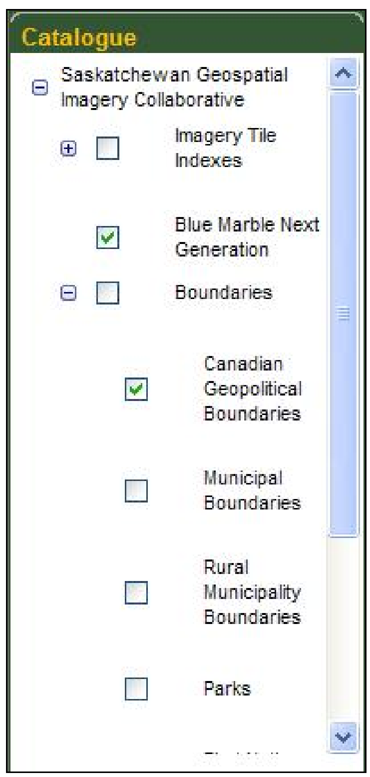

Figure 12. Catalogue Tool Panel

- Search Tool – the search tool provides a number of methods of searching for specific features. Users can enter a set of geographic co-ordinates, a township system grid reference, an NTS map sheet reference, an urban community name, or first nations reservation name. If the name is found in the SGIC system database, the map panel will be scrolled to show the requested feature. The search tool control is shown in Figure 13, and the municipality name search dialog is shown in Figure 14. Note that some of the search types, such as municipality, use a suggestion oracle to pop up a list of names that are close to the search term you enter in the name field.

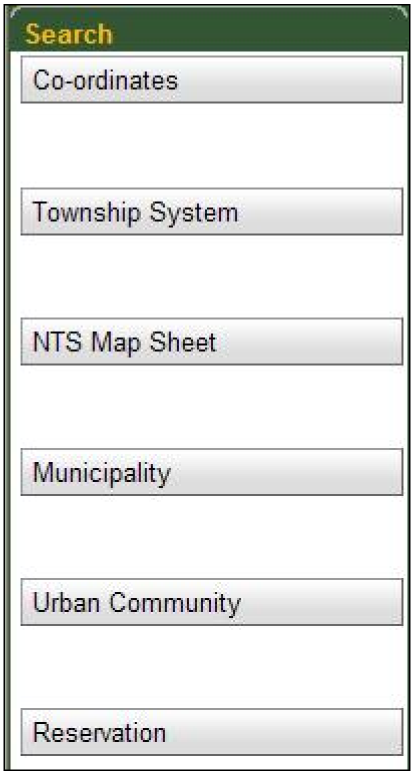

Figure 13. Search Tool Panel

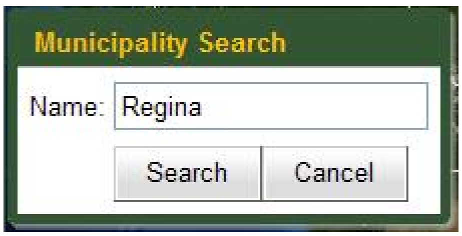

Figure 14. Municipality Search Dialog

- Download Tool – the download tool provides a way for users to save a geospatial image file on their computer. It is only available to SGIC members, and its use is covered in a separate manual.

- User Administration Tool – the user administration tool provides a way for SGIC member organizations to manage their own users of the system. It is only available to SGIC members, and its use is covered in a separate manual.

- Data Administration Tool – the data administration tool provides a way for SGIC member organizations to manage their own geospatial data. It is only available to SGIC members, and its use is covered in a separate manual.

Conclusion

With this simple to use yet powerful set of web mapping tools, SGIC users are able to create accurate and detailed map images showing raster imagery and vector features.

Exercises

Using the web mapping client, create a map of your home town in Saskatchewan. Explore the different data sets available in the catalogue tool, and use the download tool to download a final map image and save it or print it out.

Chapter 2
Using the SGIC web map service

Introduction

Web mapping clients are sufficient for basic mapping purposes, but advanced mapping users have the option of using the SGIC data through Open Geospatial Consortium web services. Using service such as the Web Map Service and Web Feature Service, users can bring layers fro mthe SGIC database into their own mapping applications, such as ESRI ArcGIS and AutoCAD Map-3D. These applications can then be used to perform advanced spatial analysis and mapping using the SGIC data.

The SGIC servers support two OGC web services:

- The Web Map Service – this service provides raster images of map data in a variety of imagery formats; and,

- The Web Feature Service – this service provides information on vector features, using the Geographic Markup Language (GML) format.

Access the WMS Capabilities Document

Use of the Web Map Service begins with a capabilities document, which describes all of the layers available through the service and the formats they can be requested in. The capabilities document is made available in a published XML format and can be saved for later use or loaded into a web browser such as Internet Explorer for viewing. The document is retrieved through an HTTP GET request to the server.

To retrieve the capabilities document, use the following URL:

http://www.flysask.ca/cgi-bin/public.cgi?service=WMS&version=1.1.1&request=GetCapabilities

Your browser will ask if you want to save the XML document or open it. A sample of the capabilities document, opened in Internet Explorer, is shown in Figure 16. Many mapping client applications will process the capabilities document automatically.

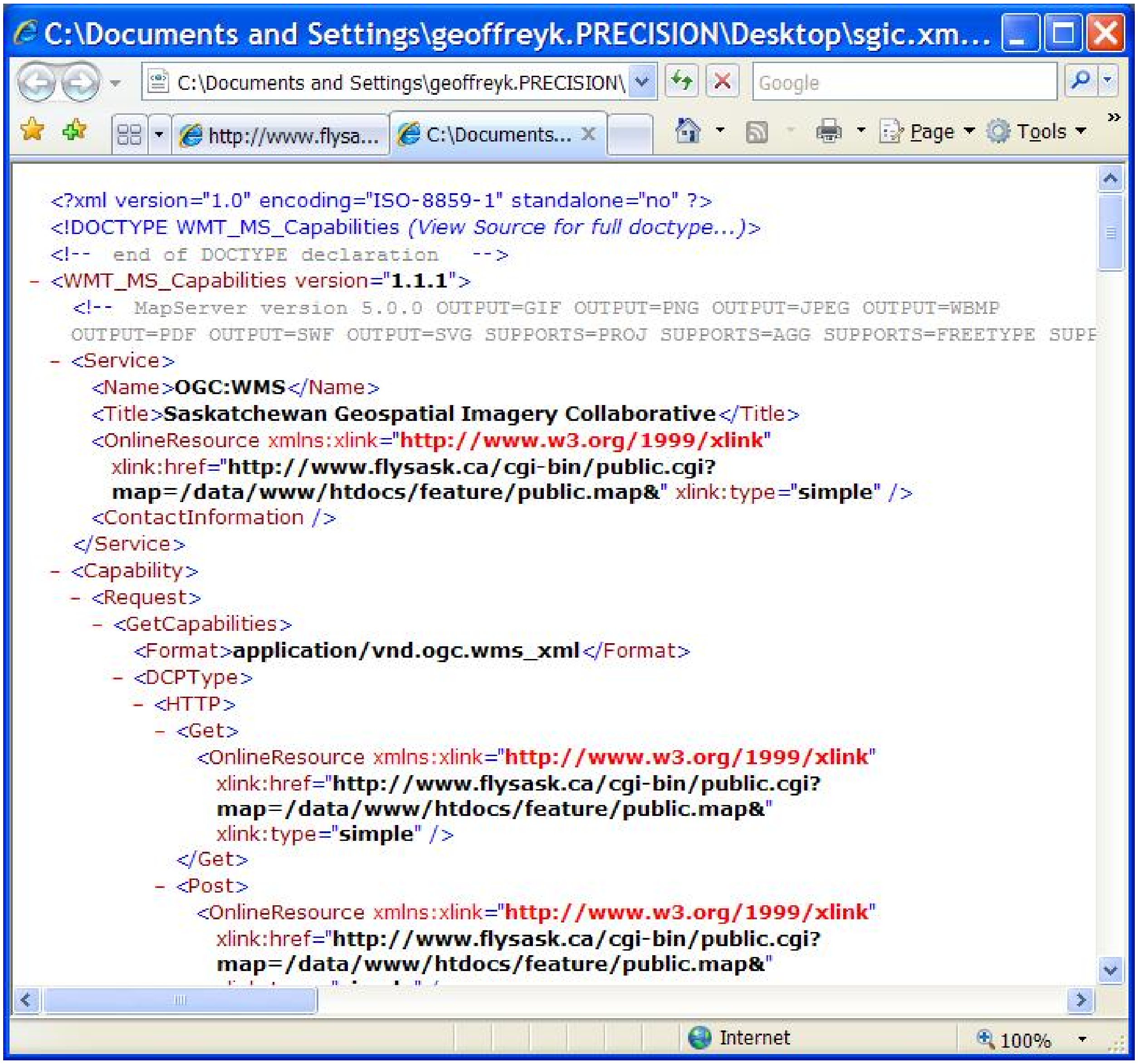

Figure 16. WMS GetCapabilities Results

Access a WMS Map

With the capabilities document, it is possible to see the names of the layers that are available from the server through the Web Map Service. Layers are described in a <Layer> tag, and any layer that has a Name attribute can be included in a map generated by the Web Map Service.

Raster maps are retrieved from the Web Map Service using a GetMap request. This request is also made through an HTTP Get request to the server. The request must include information such as the requested layers, projection, and extent to use for the raster image that will be generated by the server. A complete GetMap request uses the following URL:

http://www.flysask.ca/cgi-bin/public.cgi
?request=GetMap
&service=WMS
&version=1.1.1
&styles=
&srs=EPSG:4326
&format=image/jpeg
&bbox=-136.,33,-73,73
&format=JPEG
&width=600
&height=600
&layers=bmng,prov

The resulting map image is shown in Figure 17. This map image is similar to the image shown in the web mapping application.

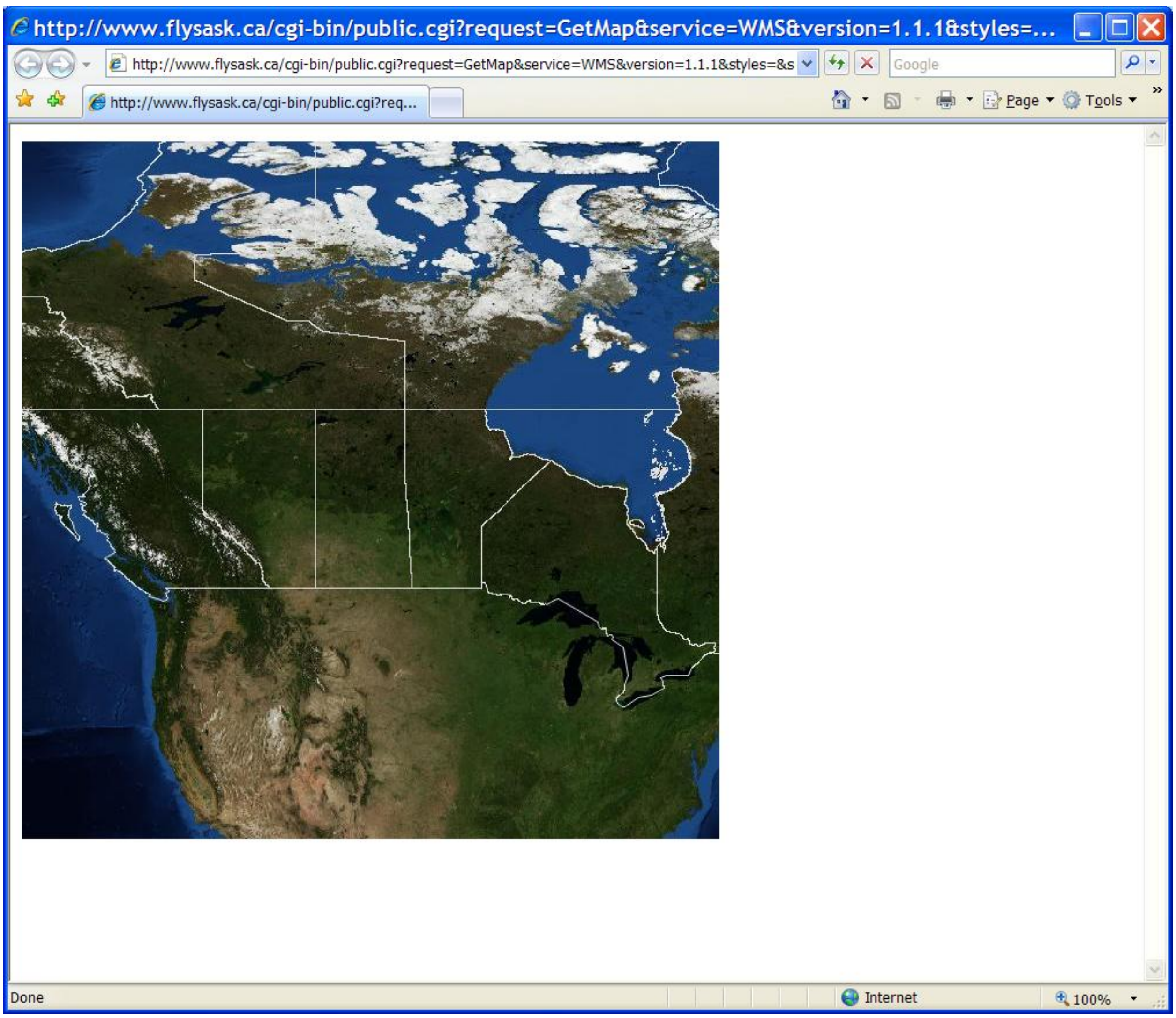

Figure 17. WMS GetMap Results.

Conclusion

Most advanced mapping applications will only need to know the first part of the URL to access the SGIC web mapping application. However, knowing how to access the service using Internet Explorer is an excellent debugging tool for verifying connectivity.

Exercises

Create an image using a the WMS capabilities document and the WMS GetMap request, similar to the image you downloaded from the web mapping client n the previous chapter's exercise.

Appendix A - Introduction to Geospatial Data

Introduction

Geospatial data consists of information that is tied to a location on the surface of the earth. For example, when a digital image captured by an aircraft is given an accurate location, it becomes useful for visualizing the surface of the earth and for identifying the features that are visible in the photograph.

Our goal with the SGIC system is to share geospatial data in a way that people can use it to make accurate maps. This introduction to geospatial data has been written to give administrators a basic understanding of how geospatial data is organized and what is involved in using it to draw a two-dimensional map on the computer screen.

Types of Geospatial Data

Geospatial data typically comes in one of two types:

- Vector Data – this is data that represents shapes, such as points, lines, ellipses, and polygons, tied to locations. For example, vector data representing the locations of the roads in Saskatchewan is available and consists of a series of lines with each endpoint specified with a geographic location. Vector data is available in a variety of formats, such as:

    - ESRI Shapefile
    - OGC Geographic Markup Language

  In addition to location information, vector data is often supplied with a database of attributes for each location. For example, the road vector data contains attributes for each line segment that describe the highway number, how many lanes are available on the highway, and what sort of surface the highway is paved with.

- Raster Data – this is data in bitmap format that represents a digital image of the surface of the earth. For example, an image captured by a camera on an orbiting satellite can be assigned to a location by identifying control points on the surface of the earth and then used for visualization purposes. Raster data is available in a variety of formats, such as:

    - TIFF
    - GeoTIFF
    - JPEG
    - Windows Bitmap
    - ECW
    - MrSID

  Some of these formats, such as GeoTIFF, include the geographic location in a single file. Others, such as JPEG, must be provided with a 'World file' that describes the geographic extent of the location that the image covers.

Geospatial data is typically organized in sets called 'themes,' with each theme containing a number of 'features.' Each feature corresponds to a specific type of object in the data. For example, the national road network data set is a theme containing geospatial data on roads in Canada, organized into features such as linear road segments. As new data becomes available for a given feature a new 'version' of the feature may be made available, such as when new roads are added to the road segment feature in the national road network theme. With a selection of features, it is possible to draw complicated maps by superimposing layers of vector features on top of a raster feature.

Ellipsoids

The earth is not precisely spherical – it is an ellipsoid, sometimes referred to as a spheroid. Furthermore, it is not perfectly flat – mountains and valleys on the surface of the earth are captured by a shape known as the geoid. The spheroid and geoid are illustrated in Figure 1. In order to understand how to draw geospatial data on a flat computer screen, it is important to know what model of the spheroid to use with the data. The common models used in Canada are known as GRS80 or WGS84.

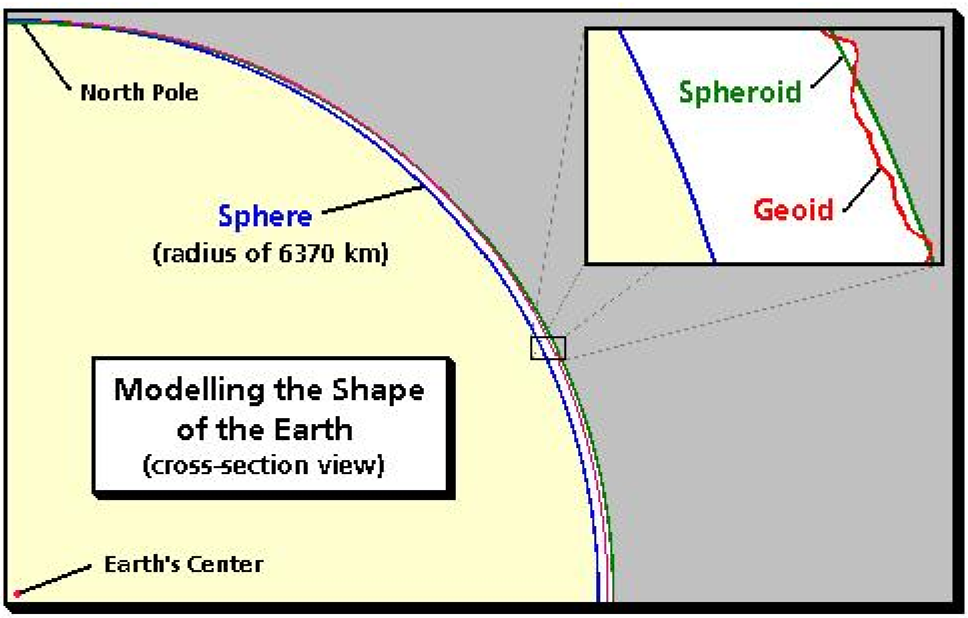

Figure 1. Modeling the Shape of the Earth. Credit: Dylan Prentiss, Department of Geography, University of California, Santa Barbara.

Projections

In order to give an accurate representation of the surface of the earth on a flat two-dimensional computer screen, geographic data must be projected. This involves selecting a mathematical algorithm for displaying the surface of the earth in two dimensions, and applying this algorithm to the data. Shifting geospatial data from one projection to another is known as reprojection.

There are thousands of projections used with geospatial data, each of which is ideal for representing a particular portion of the earth. Each projection also causes other portions of the earth to appear distorted. For example, in Canada, it is common to see maps presented in a cylindrical (geographic) projection, but this tends to make the northern portions of the prairie provinces and the territories look excessively large. To correct for this, a lambert conformal conic projection is often seen on maps, which gives the northern parts of the country a more natural appearance. This is shown in Figure 2. A transverse Mercator projection is also used commonly for small-scale paper maps, which allows for accurate navigation over the area of the map but would cause distortion over a larger scale. An example of a transverse Mercator projection for Canada is shown in Figure 3.

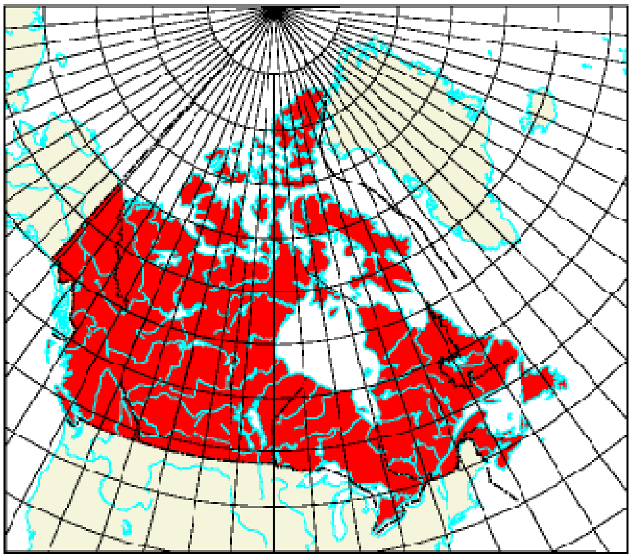

Figure 2. Map of Canada, Lambert Conformal Conic Projection. Credit: The Atlas of Canada.

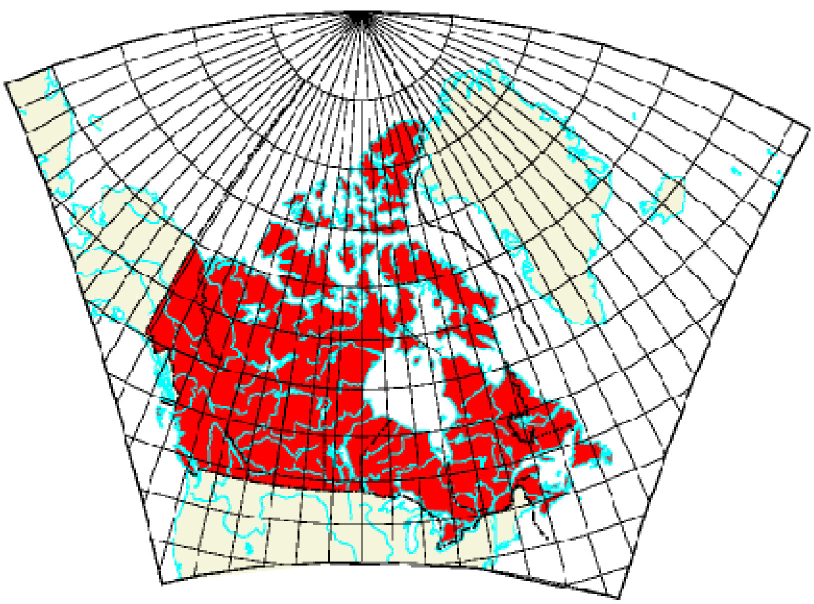

Figure 3. Map of Canada, Transverse Mercator Projection. Credit: The Atlas of Canada.

Co-ordinate Systems

Co-ordinate systems allow a user of geospatial data to identify a location on the surface of the earth. The most common co-ordinate system in use is the “Geographic” co-ordinate system. In this system a measure of latitude consists of an angular measure in degrees, minutes, and seconds north or south of the equator. Similarly, a measure of longitude consists of an angular measure in degrees, minutes and seconds east or west of the prime meridian running through Greenwich, England. It is common to see degrees of longitude west of the prime meridian expressed as a negative number – for example, the Alberta-Saskatchewan border is longitude -110°.Latitude and longitude may also be expressed in decimal degrees, where the minutes and seconds of an angle are converted to a decimal portion of a degree.

A combination co-ordinate system and map projection used extensively in Canada is the Universal Transverse Mercator (UTM) system. In this system, the earth is divided into zones six degrees wide. These zones are then ‘unwrapped’ into rectangular strips, one north of the equator and one south of the equator. Measurements are then taken as a northing and easting from the edges of the UTM zone, measured in metres. UTM Zones for Canada are shown in Figure 4.

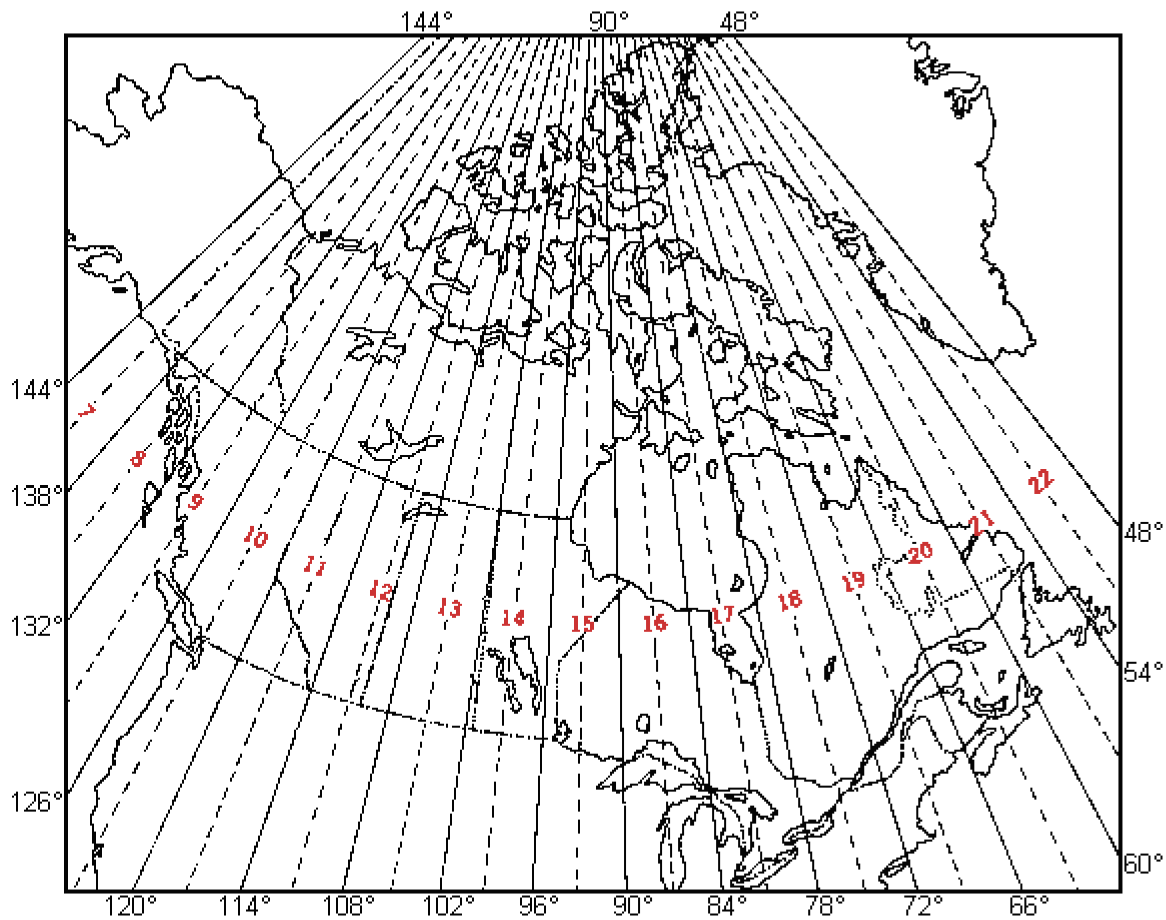

Figure 4. UTM Zones and Central Meridians for Canada. Credit; Natural Resources Canada, Centre for Topographic Information

Co-ordinates may include a third measurement representing the elevation of a location above the surface of the earth. Elevation information can be used to create three-dimensional visualizations of the surface of the earth and the features on it.

Datums

In order for users of geospatial data to be able to arrive at the same location on the surface of the earth, their measurements must start from a common reference location, or datum. Shifting geospatial data from one datum to another is known as datum shifting.

In Canada, the North American Datum 1927 (NAD27) was used for many years, and a large volume of data still exists that uses this datum. More recently The North American Datum 1983 has come into general use, based on the GRS80 ellipsoid, and users of geospatial information are encouraged to adopt this datum for new data whenever possible.

Spatial Reference Systems

Combining information on projection, co-ordinate system, and datum allows us to arrive at a complete description of the spatial reference system used to describe geospatial data. In order for users of geospatial data to obtain an accurate map, they must know the original spatial reference system for their data, the final spatial reference system they want to arrive at, and the mathematical algorithms needed to reproject and shift the data between the two.

Fortunately, software libraries are available which contain the algorithms needed to reproject and shift geospatial data. One of the most commonly-used libraries for this purpose is the “proj4” open source library. It uses a string representation to describe spatial reference systems. For example, a UTM zone 13N NAD83 projection using the GRS80 ellipsoid could be described in the proj4 format as:

+proj=UTM +zone=10N +ellps=GRS80 +datum=NAD83 +units=m

Another useful development in spatial reference systems has been the definition of a standard set of spatial reference identification codes by the European Petroleum Survey Group (EPSG). For example, EPSG code 26910 corresponds to a proj4 text description of the UTM projection described in the previous paragraph.

Sometimes vector data is supplied with a projection (.prj) file that describes what projection the data is in. If this information is not provided in a projection file, it is usually available in the metadata accompanying the vector data.

Scale

The two-dimensional map generated on the computer screen from geospatial data has to apply a scale factor in order to show all of the data. Map scales are expressed in a format such as screen units:map units. So, for example, a 1:10 million map scale, means that one centimeter measured on the screen corresponds to 10 million centimeters measured on the ellipsoid. A 1:25 million map scale is useful for displaying all of Canada on the screen, while topographic maps are often drawn at scales of 1:250,000 or 1:50,000. Examples of a 1:50,000 map sheet and a 1:250,000 map sheet for the same area of Canada are shown in Figures 5 and 6.

Figure 5. Sample of NTS 1:50,000 Map Sheet 031G05 for Ottawa. Credit: Natural Resources Canada, Centre for Topographic Information

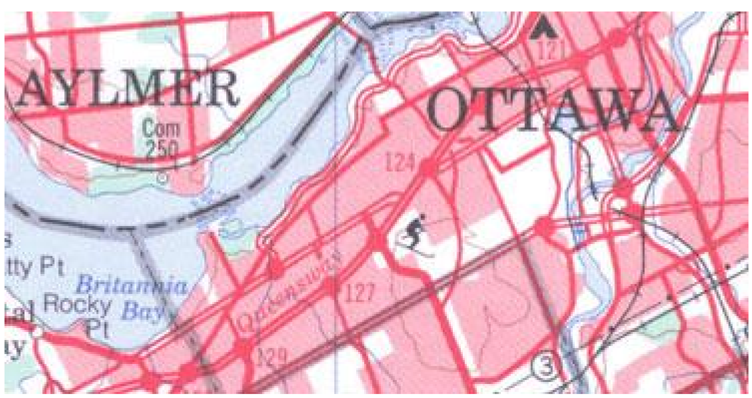

Figure 6. Sample of NTS 1:250,000 Map Sheet 031G for Ottawa. Credit: Natural Resources Canada, Centre for Topographic Information

Metadata

Metadata, or ‘data about the data,’ is available with most geospatial data sets to describe information such as the spatial reference system. It also describes the technical steps that were used to prepare the data, and explains the attribute data that is included in the data set. Metadata is usually provided in an .xml file in the FGDC format, which includes a number of standardized fields. In other cases, metadata may br provided in a format such as a .pdf file.

Using Geospatial Data

In the SGIC web mapping application, we have attempted to strike a balance between ease of use and the need for precise data. The application uses a cylindrical (geographic) projection, EPSG code 4326, in order to simplify user operations such as selecting a download extent. When downloading a map image, users can choose a different projection and have the server reproject their image before it is made available.

Data in the geospatial database provided for the application is organized into themes, features, and versions. Maps in the application consist of layers containing features from the mapping database, and can either be set up to use the most recent version of a feature or a numbered version. The catalogues that users interact with are generated from maps, and are used to select layers for display on the screen.

A key consideration for administrators, especially when adding new data to the system, is to know what projection the data is in before it is added. This can usually be obtained from the metadata available for the file, or from a .prj file if one has been supplied. All projections in the application are specified using EPSG codes. Data is stored in the spatial database in the projection that it was supplied in, and is reprojected to EPSG code 4326 (geographic cylindrical projection ,NAD83 datum, WGS84 ellipsoid).

The application provides a facility for storing metadata. If metadata is supplied, it is made available to the user by clicking on the metadata icon next to a feature in the web mapping application’s catalog control.

References

The Atlas of Canada – Map Making.
http://atlas.nrcan.gc.ca/site/english/learningresources/carto_corner/index.html

Natual Resources Canada, Centre for Topographic Information.
http://maps.nrcan.gc.ca/index_e.php

Appendix B - Introduction to SGIC Hardware / Software

Introduction

The SGIC hardware and software environment is designed to share imagery data through two separate interfaces: a web-based mapping client application, and the Open Geospatial Consortium (OGC) Web Map Service (WMS) for use by other mapping applications. This chapter describes the hardware and software environment used to achieve this goal.

Physical Architecture

The physical architecture of the SGIC system is shown in Figure 7. It consists of two identical servers (test server and production server), a firewall, and a tape backup system. Each of the servers runs identical sets of software, and can be used interchangeably in the event of a system failure. Users of the SGIC system access it using a web mapping client connected over the internet. The web mapping client may either be the SGIC's own web mapping client, or another piece of client software such as ESRI ArcMap or AutoDesk AutoCAD, which are able to connect to the SGIC's Web Map Service.

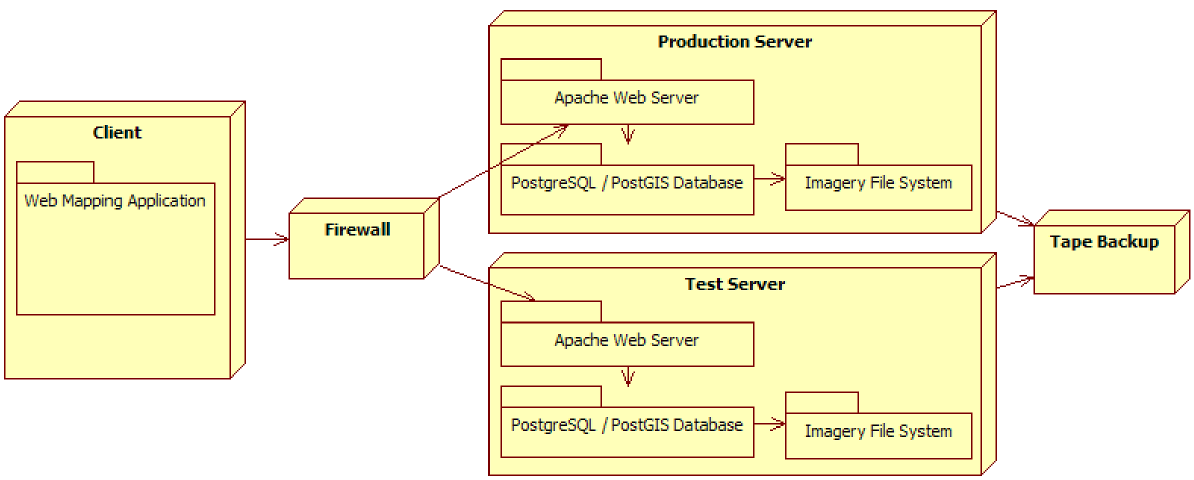

Figure 7. Physical Design

Deployment Architecture

The deployment architecture for the SGIC system is shown in Figure 8. It consists of five software components:

- A public and secure access web mapping client applications, written using the Google Web Toolkit;
- Public and secure access CGI scripts for manipulating geospatial data, written in PHP; and,
- The OpenLayers open source web mapping JavaScript component

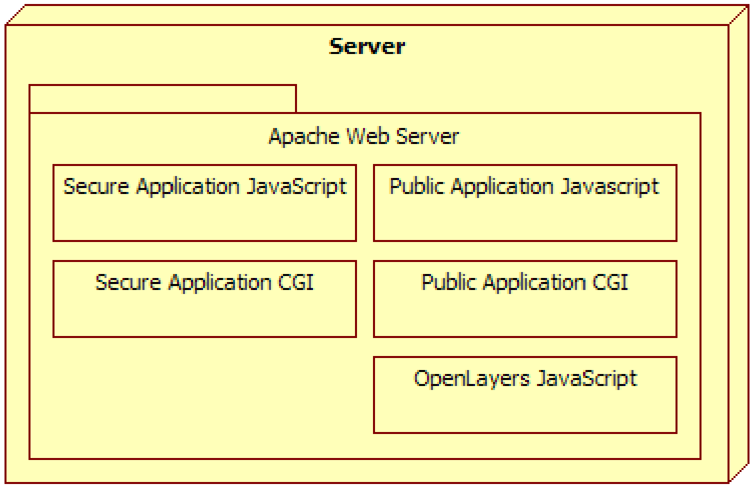

Figure 8. Deployment Architecture

Both secure and public access versions of the web mapping application will be available for download to the client's web browser. Similarly, secure and public sets of CGI applications are available on the web server. The reason for providing separate secure and public versions of the applications is to meet the requirements for secure access to the application by SGIC members. In addition, the open source OpenLayers application will be available for both secure and public versions of the application.

Web Mapping Application Description

The web mapping application can be used by SGIC users to view and download imagery. It was written in Java with the open source Google Web Tookit, using OpenLayers to provide a mapping interface.

The application is support a variety of options for controls available to the user and a security model. Upon startup, the application retrieves an XML file from the same directory the application was loaded from using an HTTP GET request. This XML file provides application definition parameters to the application, such as the location of WMS servers to include in the catalogue and whether or not to require security authentication.

The web mapping application uses the OGC Web Map Service for accessing geospatial data. A WMS GetCapabilities request is sent by the application to the WMS server specified in the configuration XML file to retrieve information on layers available to include in the catalogue control. A series of WMS GetMap requests are then used to retrive map images in the OpenLayers control. In order to provide a good balance between downloading of detailed imagery and fast response times, raster data such as imagery is loaded as a set of 'tiles' by the OpenLayers control, while vector data is loaded as one compelte image with transparency, overlaid on top of the raster data.

Web Map Service Description

A WMS server implementation provides basic Open Geospatial Consortium version 1.1.1 compliant web map services. In order to meet the OGC standard, a WMS server must implement the GetCapabilities and GetMap operations.

UMN MapServer is an open source piece of software that implements the Web Map Service. Specifically, UMN MapServer implements the Web Map Service GetCapabilities request to provide information on available layers in an XML document. It also implements the Web Map Service GetMap request to provide map images in a variety of formats and projections.

Summary - Development Environment Software

Software	**Version**
CVS Concurrent Version System	
Google Web Toolkit	1.5
OpenLayers	2.6
Eclipse Platform IDE	3.3.0

Table 1. Development Environment Software

Summary - Run-Time Environment Software

Software	**Version**
HostGIS Linux - Apache Web Server - UMN MapServer - PostgreSQL - PostGIS	4.2
Alfresco Web Content Management	2.1
Google Web Toolkit	1.5
OpenLayers	2.6
Web Browser - Internet Explorer - FireFox	

Table 2. Run-Time Environment Software

References

HostGIS Linux. http://www.hostgis.com

UMN MapServer: http://mapserver.gis.umn.edu/

Apache Web Server: http://httpd.apache.org/

PostgreSQL: http://www.postgresql.org/

PostGIS: http://postgis.refractions.net/

OpenLayers: http://openlayers.org/

Google Web Toolkit: http://code.google.com/webtoolkit/

OpenSSH for Windows: http://code.google.com/webtoolkit/