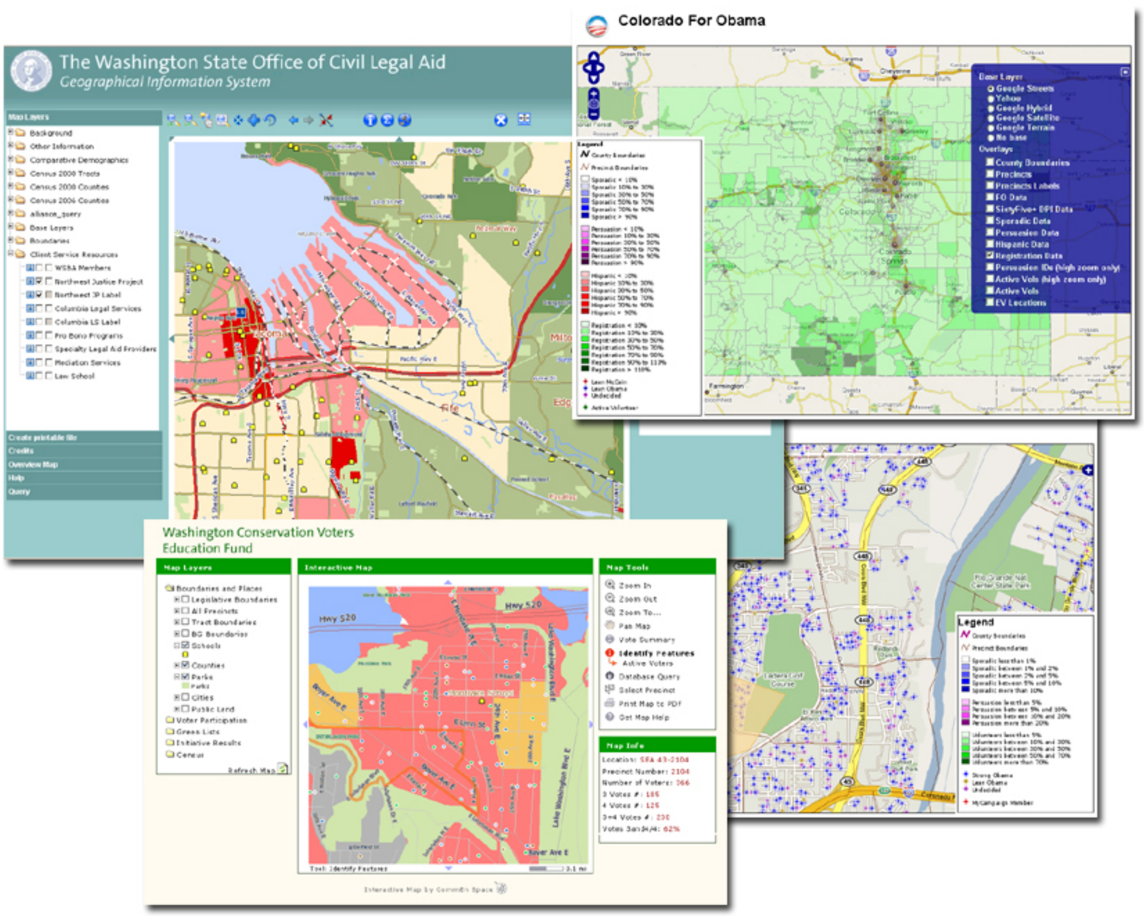
Interoperable Web GIS Solutions with Open Source Software

Introduction for intermediate and advanced GIS users



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1 FOSS Overview

1.1 What is Open Source (GIS)?

Open Source is not synonymous with Open Standards

Open source[1] means that the source code is available to the general public for use, distribution, and modification from its original design free of charge (among a long list of other requirements). Other acronyms frequently used in the OS GIS world are FOSS[2] and FOSS4G [3]. Free in this context is meant to express that the software is free (like in freedom or liberty) and free of charge[4]. While most open source geospatial software is built on the standards of the Open Geospatial Consortium (OGC) the term "Open Source" is not synonymous with Open Standards because both proprietary and open source software can be compliant with the OGC Open Standards.
http://www.opengeospatial.org

OGC sets standards

The OGC is a consortium of proprietary companies, scientific organizations, government agencies and representatives of the open source software movement that develops and publishes software interface specifications (OGC standards).

OSGeo supports the development of open source geospatial software

OSGeo is the organization that supports the development of the highest quality open source geospatial software
http://www.osgeo.org.

The Tribes Concept

Proprietary and open source software can be compliant with OGC standards. However, adoption of OGC standards is usually higher among OS software packages. One characteristic of OS software is that it extensively uses synergies in software development. Libraries are shared to a big extent and the high adoption level of OS software makes them highly suitable for interoperable software solutions. However, Ramsey (2007)[5] listed the following *tribes* (referring to their communal use of software programming languages or the medium, like the web

[1] in the following referred to simply as OS
[2] Free and Open Source software
[3] Free and Open Source software for Geospatial (Applications)
[4] Due to a short coming of the English language which has no word for it, it is also sometimes referred to as *free as in beer* (gratis)
[5] The State of Open Source GIS, Version September 2007

for which the packages are primarily designed.

Table 1: The tribes of FOSS4G

Tribe	FOSS4G Projects
C/C++	MapServer, GRASS, MapGuide, QGIS, PostGIS, OGR/GDAL, PROJ4, GEOS, FDO
Java	GeoTools, GeoServer, uDig, DeeGree, JUMP, gvSIG
Web	MapBender, OpenLayers
.Net	SharpMap, WorldWind, MapWindow

Reasons to use Open Source software

user control

User is in control

- Pick your favorite operating system: Windows-Linux-Solaris-Mac
- No licensing issues (did we install one to many PCs with software XY?)
- Vendor independency
- Access to source code: don't like something, need changes to the core system, need extensions - hire somebody to change it right now

performance quality interoperability

High performance, high quality, high interoperability

- distributed programming effort, highly modular
- System heterogeneity - less prone to hacker attacks and viruses. Highly interoperable, very advanced support of OGC open standards

support

Support - Commercial and non commercial

- Mailing lists, user groups, Conferences, IRC channels
- Fast response times for bug fixes
- typically tracked on the web, accessible and open to everybody to report or fix a bug

free

Last but not least - It is free

1.2 The FOSS Culture

give take contribute

Often the FOSS movement is referred to as not only a model on how to create, distribute and license software but rather a culture. A lot of times business people don't understand why one would create something useful and just give it away instead of selling it. Thus, many times they infer that there must be a catch, something must be wrong with the product, since it is free it must have no value and other misconceptions.

contribute
•source code
•documentation
•answer questions on mailing lists
•support and fund OSGeo

There is much more to it than producing free and open software. It is a way of doing things, of working together, of collaborating, a movement of people around the globe, in short a culture. It is appreciated when people using the software are giving something back to the community. That might be helping others in the user list and online forums, writing documentation about something you learned about using the software in the online wiki pages[6] of the project, writing new source code or customizations and sharing it with the community. The community is working like an organism and the organism does better if all parts are working together.

1.3 History

1960's most software is free
1983 Free software Foundation and the GNU Project
1991 Linux
1995 Apache HTTP server
Eclipse programming platform
1998 Open Source Initiative founded

Before the 1960's it is safe to say that most software was free (*libre*). Only in the late sixties and seventies proprietary software was *born* and quickly dominated the software landscape. In 1983 Richard Stallman, a former programmer at the MIT laboratories founded the Free software Foundation and the GNU Project. One of the major goals of GNU was to create a free operating system and to establish licensing terms for FOSS.
A few of the milestones for general OS software development where the first release of the Linux operating system in 1991, the release of the Apache HTTP server in 1995, and the increasing involvement of software heavy weights such as IBM (Eclipse programming platform) and SUN Microsystems (Java programming language and tools) since the late 1990's.
In 1998 the Open Source Initiative a, non-profit corporation, was created with the goal to educate about and advocate for the benefits of open source software. On their website http://www.opensource.org they state:

"*Open source is a development method for software that harnesses the power of distributed peer review and transparency of process. The promise of open source is better quality, higher reliability, more flexibility, lower cost, and an end to predatory vendor lock-in. The Open Source Initiative*

[6] a web page/collection of pages that enable anyone to contribute, modify and share content

(OSI) is a non-profit corporation formed to educate about and advocate for the benefits of open source and to build bridges among different constituencies in the open-source community. One of our most important activities is as a standards body, maintaining the Open Source Definition for the good of the community. The Open Source Initiative Approved License trademark and program creates a nexus of trust around which developers, users, corporations and governments can organize open-source cooperation."

1.4 licenses

FOSS4G licensing general terms

A variety of licensing types exists for Free and Open Source software. Some of them are more restrictive than others. According to the current OSGeo president Arnulf Christl's talk at FOSS4G 2008, most of the licenses specify the user's rights to

- run any number of copies of the software
- pass on copies of the software including the license and copyright notice
- look into the code, understand it and modify it to suit one's needs
- pass on modified versions of the code

What is copyleft?

From a word play with the term *copyright* resulted the newly coined term *copyleft* which similarly quotes the following freedoms for users to use and study the work, copy and share the work with others, modify the work, and to distribute modified and therefore derivative works. The idea of copyleft is that work derived from the original OS software will have to be distributed under the same liberal or equivalent license terms.

Common FOSS software Licenses

GNU License

The most popular OS software licenses for geospatial applications are listed below. Brief descriptions for each of the these licenses (quoted from Wikipedia) are included in the resource section of this booklet.

Table 2: List of common FOSS software licenses

Name	Style	software
GNU-GPL	strong copyleft license, derived works have to be available under the same copyleft	GRASS, QGIS, gvSIG, Mapbender, PostGIS, GeoServer, AveiN!
LPGL	compromise between copyleft and more permissive licenses, has copyleft restrictions on the program itself, but not on other software linking with the program.	Mapnik, MapGuide
MIT	permissive license, permits reuse within proprietary software (license has to be distributed with that software)	MapServer, GDAL/OGR, Proj4
BSD	permissive license, little restriction, close to the public domain	FeatureServer, TileCache, OpenLayers
Mozilla (MPL)	hybrid of modified BSD and GPL.	MapWindow, Mozilla Firefox

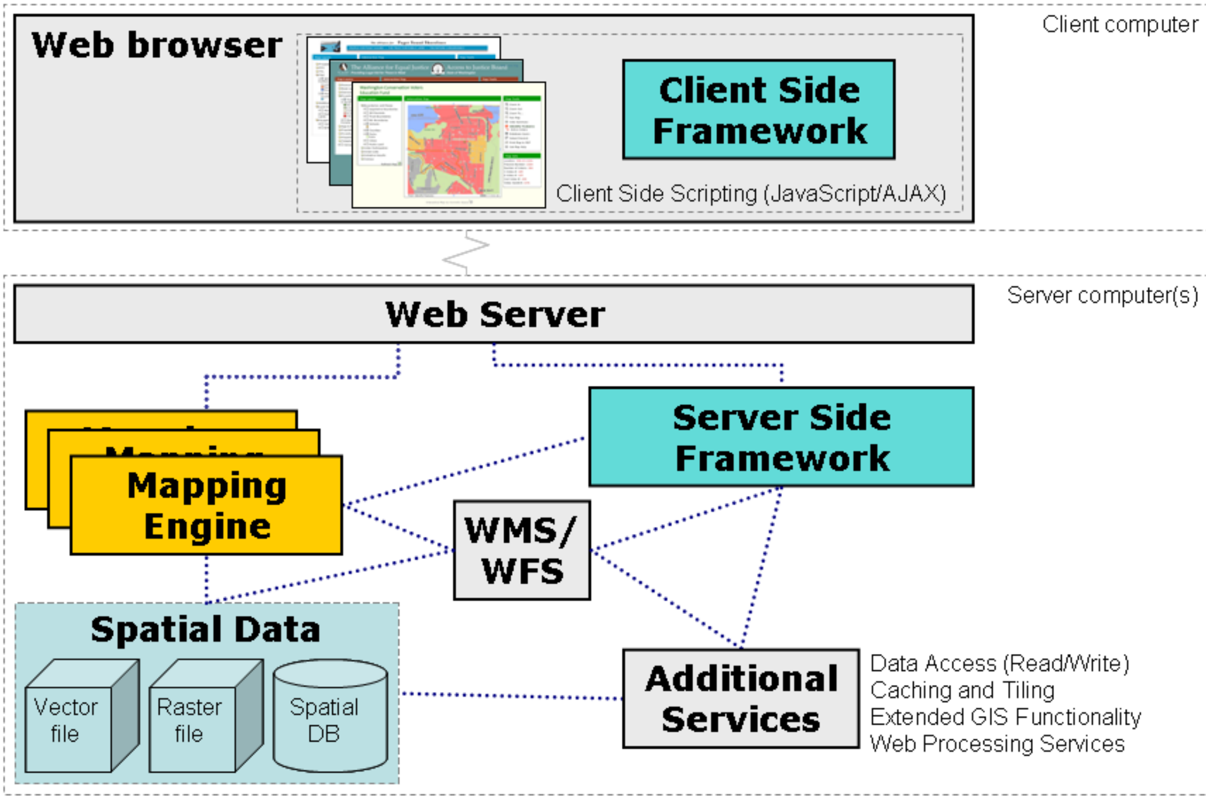

Figure 1: Schematic view of Interoperable Web GIS

2 FOSS Web GIS Components

Web GIS frameworks can either be client side based only or include a server and a client side. One pretty common client program is a modern web browser that has scripting enabled (JavaScript) and thus can run some part / or most of the application on the client computer. If an application does most of the processing on the client side it is called a thick client. Examples for thick clients are Google Earth, ArcGIS, or uDig.

thick client e.g. Google Earth ArcGIS uDig

If most of the processing takes place on the server and only the images are sent over to the client or are requested by the client this is called a thin client e.g. OpenLayers or Google Maps. In a simple case where all the application components are hosted on one server machine this includes at least the Spatial data such as vector and raster files and/or a spatial database. These data can then be rendered as images by

thin client e.g. Openlayers Google Maps

a Mapping engine (e.g. MapServer, GeoServer, Mapnik or ArcIMS) and served via the HTTP web server (e.g. Apache or MS IIS) to the web. Mapping engines can be used to publish as web mapping services (WMS) or web features services to the web (WFS). The server side can also be complemented by a framework or content management system that provides for functionalities such as user authentication, user access rights management, user interface customization, tools and functionality management and more. Such an interoperable web GIS system can be extended by additional server side components that provide functionality such as caching and tiling, GIS analysis functionality (e.g. via PostGIS intersections and reprojection) or web processing services (WPS).

WMS
web mapping service
WFS
web feature service

2.1 Web GIS Engines

2.1.1 MapServer

UMN MapServer

MapServer is a map rendering engine that was developed at the University of Minnesota (UMN), short MapServer. It is one of the most mature and most successful open source GIS projects and is implemented in C. The main focus is on rendering spatial data and in providing a development environment for spatially-enabled Internet applications. Some of the highlights about MapServer are that it supports more input data sources than most of the proprietary products, has higher performance, and the pre-compiled versions are simpler to install and set up. There are two main ways that one can interact with MapServer using it as a CGI[1] application or using one of several MapScript APIs to write your custom application. The MapScript API[2] is available for PHP, Python, Perl, Ruby, Java, and C#. MapServer uses a configuration text file that commonly has the .map extension. This file tells MapServer all the information the programs needs to know to render a map. The configuration includes general information about the maps like projection, size of the map in pixels, output format etc. Individual layer tags are used to determine the classification of a layer. Examples for input formats are MapInfo files, shapefiles, PostGIS, Oracle Spatial, ArcSDE, WMS, and all GDAL and OGR formats. Output formats include GIF, JPG, PNG, all GDAL formats, WFS and WMS.

MapServer has two modes
- **CGI mode or**
- **MapScript mode**

MapScript is available in
PHP
Python
Perl
Ruby
Java
C#

[1] Common Gateway Interface is a standard protocol for interfacing external application software with web servers.

[2] An application programming interface (API) is a set of functions, procedures, methods, classes or protocols.

MapServer suite

With the release of MapServer version 6.2 its source code and several related projects where bundled to form the MapServer suite. The suite includes MapServer CGI/FCGI, MapScript, Tiny OWS and MapCache. Other useful related tools are the MapServer utilities listed on page 48. Tiny OWS is a implementation of Transactional Web Feature Service (WFS-T), a specification of the OGC that has been added to the suite as a module with the release of MapServer version 6.2.

Table 3: MapServer Project

Main supporter of **MapServer**	MapServer Core Team, Steven Lime
Functionality	Map rendering engine, web mapping development environment
Operating systems	Multi platform
Project started	1996
Implementation	C
OS libraries	OGR/GDAL
PostGIS support	Yes
License	BSD

2.1.2 GeoServer

GeoServer rendering and publishing data editing data WFS-T versioning

GeoServer is a newer development than MapServer. It covers much of the functionality that MapServer does, such as rendering images from spatial data, and publishing of WMS and WFS. It has a web-based graphical configuration and management interface and stores the configuration in XML format.

Furthermore it supports transactional capabilities and shared editing (versioning) of spatial data. GeoServer also supports KML and tiled map output. Input formats include PostGIS, shapefile, ArcSDE, DB2, Oracle (soon VPF, MySQL, MapInfo, and WFS). Output formats include JPG, GIF, PNG, SVG, KML/KMZ, GML, shapefile, GeoJSON, GeoRSS, WFS and WMS. GeoServer can currently serve WFS on top of: Oracle Spatial, ArcSDE, PostGIS and shapefiles.

Table 4: GeoServer Project

Main supporter of **GeoServer**	The Open Planning Project (TOPP)
Functionality	Map rendering engine, support for web based editing of data, transactions WFS-T and versioning
Operating systems	Multi platform
Project started	2001
Implementation	Java, J2EE
OS libraries	Geotools
PostGIS support	Yes
License	GPL 2.0

2.1.3 Mapnik

Mapnik rendering high quality maps

Map output can be via Python scripts and style sheets

Mapnik is another map rendering engine which was started by Artem Pavlenko in 2005. It appears to have a lot of potential, even though the developer and user community is still small. Mapnik is written in C++ and already delivers really nice map output based on the AGG renderer[3]. Mapnik can be used to produce maps interactively on a web server or on the desktop environment. Map output can the controlled via Python scripts and style sheets. Currently the focus is on map rendering and it does not have capabilities for editing or querying spatial data. Mapnik accepts shapefiles, PostGIS and TIFF raster as input formats, and uses a styles processor to output images in PNG, JPG, SVG, PDF, and PS formats. A tutorial for making maps with Mapnik and Python can the downloaded from `http://code.google.com/p/mapnik-utils/`.

Table 5: Mapnik Project

Main supporter of **Mapnik**	Artem Pavlenko and others
Functionality	Map rendering engine (based on AGG), Python bindings
Operating systems	Windows, Linux, Mac
Project started	2005?
Implementation	C++
OS libraries	Boost libraries, AGG renderer `http://www.antigrain.com`
PostGIS support	Yes
License	LGPL

[3]Anti Grain Geometry renderer. An OS software graphic library, written in C++ that allows to render images from vector data.

Figure 2: Three maps rendered with Mapnik

2.2 Client Side Frameworks

The following frameworks are based on JavaScript/Ajax Libraries, have no (or optional) server side dependencies and thus can be used easily on a shared hosting environment.

2.2.1 OpenLayers (OL)

OpenLayers *Geography in a browser*

OpenLayers is a pure client side mapping framework based on JavaScript and as a result is very easy to deploy. OpenLayers has no server side dependencies and provides an API that you can use independently from the data sources that supply the input data for the application. Input data sources can be tiled and pre-rendered images via WMS or commercial layers such as Bing, World Wind, Google Maps, or WMS services. Using map tiles enables a smooth map scrolling and browsing experience (slippy map) just like the commercial maps from Google, and Microsoft. Vector input for OL can come from many sources such as MapServer, GeoRSS, WFS, or KML. OpenLayers supports a variety of reusable components such as scale bars, zoom bar, layer switcher (on/off), and tools like zoom in-/out and pan. Version 3 of OpenLayers (OL3) was released on August 29th 2014 and is a full re-write using modern design patterns. OL3 breaks backwards compatibility with the 2.X versions of OL. OL3 is based on Google's Closure Tools which enable advanced compression of the library (resulting in smaller size) and ensures wide cross-browser testing. Custom builds of OL3 can be easily compiled for production software using the closure compiler.

smooth map scrolling and browsing experience (slippy map)

integration OpenLayers and EXT JS

GeoEXT http://www.geoext.org/ is a set of spatial tools extending the Ext JS JavaScript library and integrating them with OpenLayers components. It supplies an API to embed OpenLayers components such as a map or a legend in Ext panels and enables easy use of Ext components within the web application.

One easy way to include an OL maps in a web page is to simply add a JavaScript <script> tag reference to a copy of the OpenLayers .js file and one can even reference a hosted version of the OpenLayers library at http://openlayers.org/api/OpenLayers.js. OL also has tools enabling digitizing and editing [4]of data when used in conjunction with a WFS-T[5] enabled server like GeoServer. OL has close ties to TileCache, and Feature Server which are also projects from Metacarta Labs.

included in a web page via JavaScript <script> tag reference

[4]e.g. OpenLayers Editor (geops) http://www.geops.de/node/73

[5]Transactional Web Feature Services support editing of vector data.

Table 6: OpenLayers Project

Main supporter of **OpenLayers 2**	v2 OpenLayers Dev Team
Main supporter of **OL3**	v3 OpenLayers Dev Team
Functionality	Client side mapping framework to develop interactive mapping applications. OL3 better optimized for use on mobile devices
Operating systems	Windows, Linux, Mac
Project started	2005, OL3 August 2014
Implementation	JavaScript/Ajax
libraries v2:	Prototype.js and Rico library
libraries v3:	Google's Closure Tools (compiler+library)
PostGIS support	via rendering engine
License	BSD

2.2.2 Leaflet

a lightweight JS Library

Leaflet is a lightweight JavaScript library for creating client side web maps that works efficiently on desktop and mobile platforms. Weighing in with only about 33KB size it is a small library that has many functions but is lacking the more advanced 'GIS' features that especially OpenLayers 2.X (and OL 3) caters to. It is a good choice if (download) speed is the main objective, compatibility with mobile devices is important and if more advanced features are not needed in the desired web-map. Leaflet's functionality can be extended via a large collection number of plugins.

D3 Java Script library visualization using SVG

Leaflet also has notably been used in conjunction with the popular D3 (Data-Driven Documents) library. D3 is a Java Script library supporting many kinds of visualizations (such as charts) that are based on a combination with HTML, SVG and CSS. Mapping capabilities have been added to D3 over time, making it an interesting alternative for *in browser visualization* of geographic and non geographic objects. The TopoJSON format is an extension of GeoJSON that encodes topology of vector data for effective display in a browser. The latter format uses topology and therefore is eliminating redundancy in data (e.g. this means no duplicate adjacent boundaries but one shared boundary). This can result in much smaller vector file sizes (of geographic objects), that can be up to 80% smaller than their GeoJSON equivalents. D3 and Leaflet can be combined (TopoJSON is available in Leaflet via D3) as shown in this simple example. A large collection of examples shows the capabilities of the growing world of JavaScript Web maps and other interesting D3 Visualizations.

D3, GeoJSON and TopoJSON

Main supporter of **Leaflet**	Vladimir Agafonkin and others
Functionality	Client side mapping framework with focus on small library size and streamlined, mobile friendly functionality
Operating systems	Windows, Linux, Mac, Mobile devices
Project started	2011
Implementation	JavaScript/Ajax
OS libraries	none
PostGIS support	via rendering engine
License	BSD

2.3 Client-Server Side Frameworks

2.3.1 Mapbender

Mapbender

Mapbender

Mapbender is a comprehensive client and server side mapping framework. It is implemented in PHP, JavaScript and XML and based on an administration database that can be housed in either MySQL or PostgreSQL. Some of its functionality such as measuring distances on a map is only available if PostgreSQL/-PostGIS is used as an admin database. It features a web based administration interface to manage applications, application layout, user and group access rights, mapping services, available tool functionality and security for WMS and WFS via OWS proxy functionality. Functionality for each of the housed web mapping applications include displaying, navigating, editing and querying spatial data and maps. Input sources are solely OGC WMS compliant map services and WFS. In the near future it is envisioned to embed OpenLayers as a map viewing option

web based administration interface

security for WMS and WFS via OWS proxy functionality

in addition to the intrinsic Mapbender viewer.

Table 7: Mapbender Project

Main supporter of **Mapbender**	WhereGroup
Functionality	Client side and server side mapping framework, based on a database (MySQL and PostgreSQL)
Operating systems	Windows and Linux
Project started	2001
Implementation	JavaScript/Ajax, DHTML, PHP
based on	MySQL or PostgreSQL
PostGIS support	Via rendering engine
License	GPL

2.3.2 MapFish

MapFish

MapFish is a client-server web mapping framework. MapFish provides tools for creating web services that allows querying and editing geographic objects. It also provides a JavaScript toolbox including specific components for interacting with MapFish web services. It consists of two parts: MapFish server and MapFish client. MapFish Client is a JavaScript framework based on OpenLayers, Ext JS and GeoExt. MapFish Server is a Python framework (based on Pylons) that extends Pylons with geospatial functionality. There are two other implementations currently available: a Ruby/Rails plug-in and PHP/Symfony plugin. Server side functionality is implemented as a Widgets and plug-ins oriented architecture. An administration tool, **MapFish Studio** can help to simplify the configuration work and will allows to create new MapFish applications. User Interface (UI) components include: layer tree, authentication, geostatistics, query, routing, and editing (the last five are server side widgets). Features include offline support (based on Google Gears), and PDF printing (features printed as vectors, rotated maps, scale bar, legends, tables).

Adding server side framework to OpenLayers

administration tool MapFish Studio

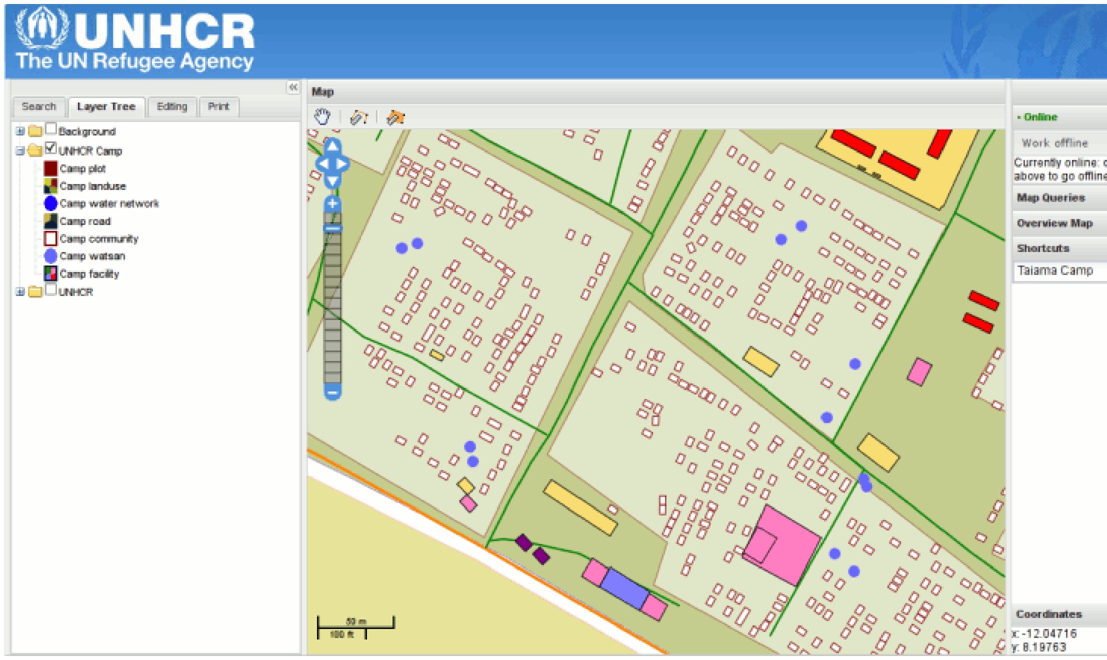

Figure 3: UNHCR web mapping application based on MapFish

Table 8: MapFish Project

Main supporter of **MapFish**	Camptocamp
Functionality	Client side and server side mapping framework, client side viewer is based on OL, supplies server side widgets, offers MapFish API
Main Focus	Adding server side framework to OpenLayers
Operating systems	Windows and Linux
Project started	2007?
Implementation	JavaScript/Ajax, DHTML, Python
OS libraries	Pylons, SQLAlchemy, GeoJSON, Shapely, JTS, and Ext JS
PostGIS support	Via rendering engine
License	GPL 3.0

2.3.3 More Great Frameworks

Django is a web development framework written in Python. It supports multiple database back-ends (PostgreSQL, MySQL, SQLite, Oracle, and MS SQL) and bundles a number of applications. Several years ago *GeoDjango* was merged into the Django main source code allowing it to be used as a web development framework for creating web based GIS applications.

2.4 Extending GIS Capabilities

Spatial data storage solutions and additional tools for web mapping applications.

2.4.1 PostGIS - The OS Spatial Database

PostGIS the coolest thing GIS ever

PostGIS is an extension for PostgreSQL and adds support for geographic objects to PostgreSQL. It enables PostgreSQL server to be used as a backend spatial database for GIS. The functionality includes data import/export, storage and retrieval of spatial geometries, and spatial indexing (R-tree) of spatial objects in PostgreSQL by adding functions, casts, and storage types. It enables spatial operations and analysis by simple means of running (spatial) SQL queries in the database. In short PostGIS is a GIS in its own right and can greatly enhance web GIS applications with additional functionality. In a sense it provides similar functions as ArcSDE but operates differently. It is not a middleware sitting on top of a database, rather it is an internal extension of the database written in C. There is no difference in the use of spatial and non-spatial objects in PostGIS and all objects are accessible via SQL queries to a GIS application.

one major difference to ArcSDE is that PostGIS is not a middleware sitting on top of a database instead it is an internal extension of the database.

When the first version of PostGIS was released in 2001 only MapServer accepted PostGIS as an input format, however over time it has become the standard spatial database backend for all the other open source GIS tools. ArcGIS 9.3 has read and write support for PostGIS but requires an ArcSDE license to connect. Prior to version 9.3 ArcGIS was lacking native support for PostGIS. ArcGIS version 10 and higher can connect to PostGIS. For editing this still looks a little different. In order

ArcGIS 9.3 has PostGIS support but requires ArcSDE

Table 9: PostGIS Project

Main supporter of **PostGIS**	Refractions Research, Victoria, Canada
Type	Spatial database. PostGIS is an extension for PostgreSQL
Functionality	Storage and retrieval of spatial data (geometries such as point, line, polygon, multipoint, multiline, multipolygon, geometrycollection). Spatial indexing. GIS functions via spatially enabled SQL. E.g. intersections, distance calculations, reprojection
Operating systems	Linux, Windows
Project started	2001
Implementation	C
OS libraries	GEOS, Proj4, OGR, and FDO
License	GPL

to edit PostGIS feature in ArcGIS 10.1 (without ArcSDE) one will still need a middleware called *Spatial Data Server* (SDS) that comes with ArcGIS Server - see this blog entry. Fortunately a new free extension ST-Links SpatialKit exists that enables display and editing of PostGIS data in ArcMap 10, 10.1 and 10.2 (version 4) and version 3.0.4 works with ArcMap 9.3 without any middleware. Another third party ArcGIS extension *zigGIS* used to be available from *Obtusesoft* but has been discontinued in 2011. In addition the *Data Interoperability Extension* also enables earlier versions of ArcGIS to use PostGIS layers.

2.4.2 Feature Server

server software for publishing, aggregating and converting geospatial data

FeatureServer is a server software (a middleware) for publishing, aggregating and converting geospatial data in a variety of different formats for the web. Published data are made available as a common web services interface. FeatureServer is implemented as a RESTful[6] Geographic Feature Service. It uses standard HTTP commands (GET, PUT, POST and DELETE) to control operations and enables dynamic capabilities to read geographic features or feature collections. Input can come from

[6] REpresentational State Transfer (REST) - style of software architecture that can be used for the web

distributed sources. It can be used to translate geographic features between formats. For example a user can input an ESRI shapefile and open it in Google Earth. FeatureServer enables feature editing and server-side storage of spatial data using OpenLayers. The following data sources (storage) are supported: DBM, BerkleyDB, PostGIS, WFS, OGR, Flickr, and OSM (Open Street Map). Service input/output formats are GeoJSON (points, lines, and polygons with rings), GeoRSS Atom (Simple), KML, GML/WFS (output-only), HTML, and OSM (output-only as Open Street Map *.osm files). Four different server operation modes are available: CGI, mod_Python, Standalone wsgi HTTP server, and FastCGI.

Table 10: Feature Server Project

Main supporter of **FeatureServer**	None (formerly it was Metacarta Labs)
Functionality	Server software for converting, tiling and caching of geospatial data
Operating systems	Windows, Linux, Mac
Project started	2007?
Implementation	Python
License	BSD

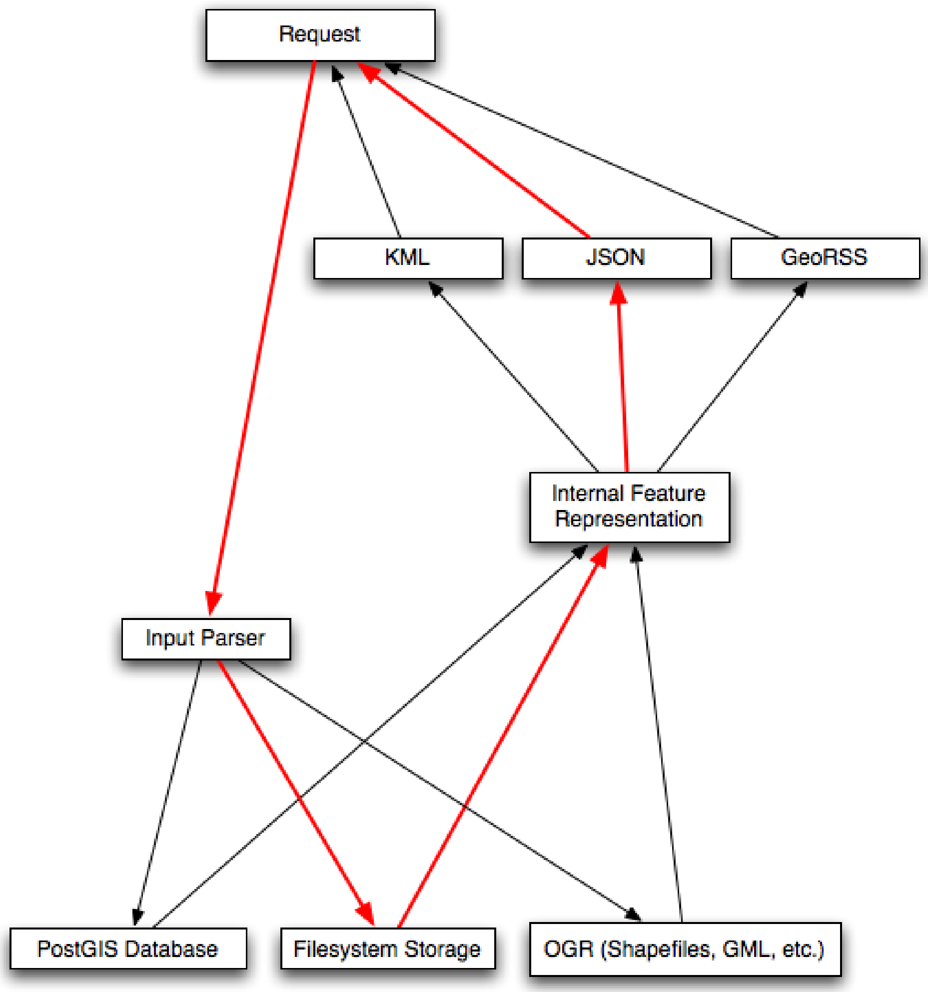

Figure 4: Schematic view of Featureserver operation. Source: http://featureserver.org

2.4.3 TileCache

creating image tiles from vector data caching on disk

TileCache is a server software solution with caching and rendering capabilities to create your own local disk-based cache of a WMS server. The tiles can be used in a variety of clients e.g. OpenLayers, Leaflet, Google Maps, MS Bing, and WorldKit. **GeoWebCache** is a similar product currently under development by Metacarta Labs but is written in Java. TileCache sits in front of map rendering engines such as MapServer, GeoServer, Mapnik or ArcGIS Server, and converts requests from front end viewers (such as OpenLayers or World Wind) into requests for maps (more exactly requests for a collection of tiles that make up a map). By caching tiles on disk the performance of a web based GIS viewer such as OpenLayers can be greatly increased. Tiles are pre-rendered and there is no need for a mapping engine to create a new image at the time of a new map request. Tile size and discrete zoom levels can be configured. Tiles can either be pre-rendered for all geographic areas (tile seeding) or only be created when requested. The use of tiles (generated by TileCache) enables smooth map scrolling experiences in applications (*slippy map feeling*) similar to those of the commercial products such as Google Maps, Bing, and MapQuest Maps. Other software packages with similar functionalities are MapProxy, MapCache (part of the MapServer suite), and TileMill, (a tiling tool for non GIS experts) - see page 81.

Table 11: TileCache Project

Main supporter of **TileCache**	Metacarta Labs
Functionality	Server middleware for converting, tiling and caching of geospatial data
Operating systems	Windows, Linux, Mac
Project started	2007?
Implementation	Python
License	BSD

3 Setup of an OS Web GIS Application

Server hosting options
•dedicated server
•virtual cloud
•shared hosting environment

There is a variety of different options for building an OS web mapping application.

Short Overview of Server Hosting Options

Depending on the goals and needs for such an undertaking one has to consider what kind of server will be available for hosting the application. For example:

- in house server with administrative access rights
- dedicated server (third party hosted machine) with root access
- shared hosting environment without root access (no administrator rights)
- hosting on a virtual cloud of computers such as Amazon EC2 or others

How to setup a GIS on a shared hosting environment

Dedicated servers can either be virtual servers (multiple virtual servers sharing one physical server computer) or real physical machines. While it is possible to install a web GIS application on a shared hosting environment this will not be the most common use case. For those interested in installing a GIS web mapping application on such an environment read on Aaron Racicot's Blog REPROJECTED GIS on a shared hosting environment. Hosting of a web GIS application on a virtual cloud of computers (such as Amazon EC2 or others) can be a good choice for certain use cases. Those environments allow for preparing images on a complete Linux server workstation installation (including GIS software stacks). Thus, those environments can be a good choice for setting up temporary servers. They can also serve as a resource for GIS analysis that has to be performed quickly. Because of pre-configured server images it is possible to start/-boot multiple machines/servers simultaneously within minutes - with all the required software installed. Those solutions are highly scalable and are available for a relatively low cost, even if you run multiple identical server machines simultaneously over a short time period.

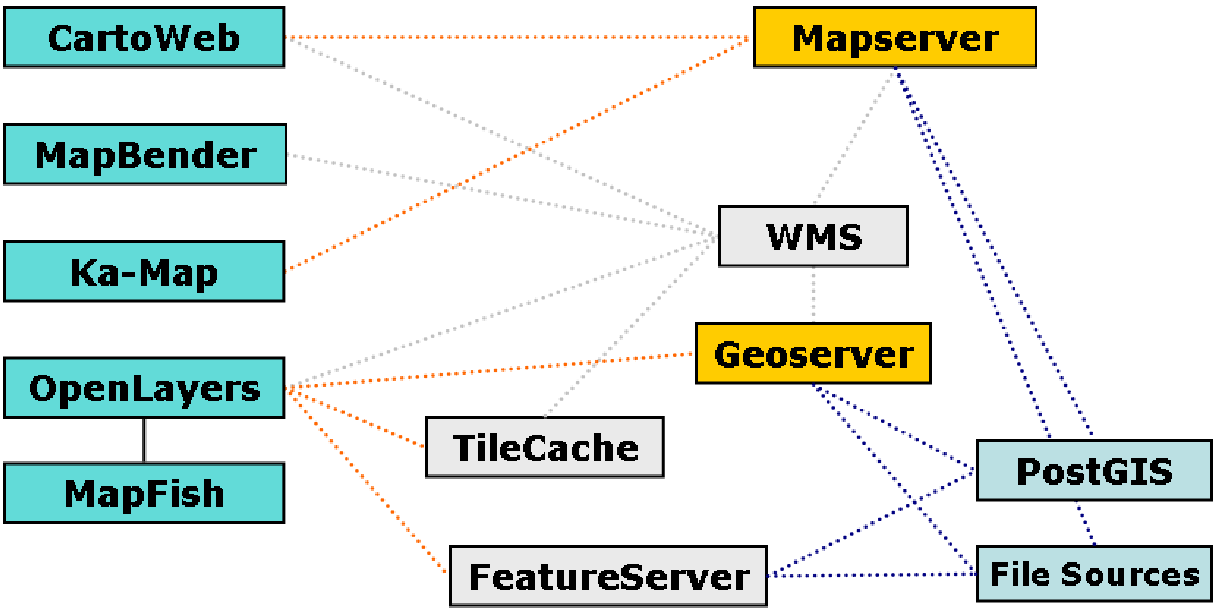

Figure 5: Schematic view of Web GIS Components

3.1 Selecting components for a Web GIS

While this can be an involved and difficult process, there is a couple of basic choices to be made. Figure5 shows the main building blocks of an interoperable web GIS solution. The data sources (in light blue) are the first building block. Data can be stored in file format or in databases. The second building block is a map rendering engine (shown as orange boxes) that can take in the data and produce some kind of map output (image or vector), which can then be served to the web either as a complete map or as a service, such as WMS or WFS (gray box) to be used in another application on the client side. Capabilities of map rendering engines can be similar to some degree, but many offer differing functionalities.

interoperable web GIS
- **Data**
- **Map rendering engine**
- **Mapping framework**
- **Map services**

GeoServer would be the engine of choice if we need editing capabilities or need support for shared editing (versioning). MapServer might be the choice if speed is the main concern and you need very high performance to render images. Some kind of mapping framework can complement the application and make the development, management and deployment of the web GIS easier. On the framework side we have to choose if we want a client side framework only (e.g. because we want to use it on a shared hosting environment - we could use OpenLayers for that), or if we have some type of dedicated server available and we need to build a complex web application. In that case we would e.g. choose Mapbender

GeoServer has editing and data versioning support

MapServer is fast

Framework client side or client-server side ?

skill set of the project team

or MapFish-OpenLayers. Which one of the frameworks we will choose depends also on the knowledge of the person (or team) working on the project (e.g. programming and scripting skills). If several of the frameworks offer the functionality needed for the project then the choice may well depend on the existing skill set of the project team. Thus, if I am already proficient with Python I might pick MapFish as my framework of choice, whereas when I am most proficient with PHP I could go with Mapbender.

Of course the framework has to enable the functionality needed for the project - or be closer to the needed functionality if new capabilities need to be developed. Many frameworks also support multiple sources of data and data intake from multiple map rendering engines to be used in the same applications. Mapbender for example can take in and manage any WMS service no matter whether it is served by GeoServer, Mapnik, MapGuide, ArcIMS, ArcGis Server, or MapServer. So the advantages and strength of several map rendering engines can be used in one framework for the greatest benefit and flexibility in the application. Additional functionalities such as the production and the caching of map image tiles, editing, aggregating, and translating of spatial data can be added by using TileCache and FeatureServer respectively. Furthermore, custom functionalities can be added using the APIs of the frameworks and the map rendering engines. PostGIS has the potential to supply GIS analysis functions to any of the frameworks. For more complicated tasks, even desktop programs such as GRASS and R (Statistical software), can be linked to the web application and potentially enable the development of a full featured web based GIS application.

TileCache and FeatureServer add tiling and caching data aggregation and translation

PostGIS adds GIS capabilities

3.2 Configuration of a Server for Web Mapping (on Ubuntu Linux)

When setting up a web server based on Linux operating systems one can naturally install your software components from scratch, including having to compile from source . This can be good choice when you want to have the most up to date software or a specific software version. However, there are other options that often will be more elegant and time efficient. Using pre-complied components for your operating system (and version) can save you a great deal of time and potential compilation trouble. The UbuntuGIS project provides easy access to relatively new software versions for many FOSS4G software

compile software from source is one option

projects. The pre-compiled packages can be installed on your Ubuntu machine using the **apt** package manager. To use apt to install OS GIS software components successfully on your Ubuntu machine there are following prerequisites

pre-compiled packages are a viable alternative

- the apt package manager needs to be installed (usually included with your Ubuntu operating system)
- the software package location has to be included in the list of repositories [1] (this is needed for the package manager to establish access to the software packages download)

Below are examples how GIS components can be installed from the bash command line using apt. The system will prompt you when additional software libraries (dependencies) will need to be installed in order to make the desired component operational.

```
# install gdal
 sudo apt-get install gdal-bin

# install proj
 sudo apt-get install proj
```

On **page 85** there is an example of how to install components using the Ubuntu and **Ubuntu GIS** repositories.

example how to install Ubuntu GIS

[1] e.g. http://trac.osgeo.org/ubuntugis/wiki/UbuntuGISRepository

4 Exercises

4.1 Using OpenLayers

Use Firefox with Firebug for web development

When doing web development some tools come in handy to debug and verify JavaScript, review requests to the server and more. Using the Firefox browser an excellent tool Firebug is available for this purpose `http://getfirebug.com/downloads`. Firebug makes it much easier to verify CSS style sheets, the DOM in web pages, review requests made to the server, debugging JavaScript and more. This can be very useful when working with OpenLayers (OL) because it is a JavaScript library and API to track down errors during coding. For example we can review the HTTP requests that OL sends to WMS services we add to a OL map.

tiled vs. untiled data sources

OpenLayers accepts a large variety of input sources and you can use it to combine data layers coming from many different locations, servers and software. OL can take in tiled or untiled data. For non-tiled vector data one has to specify the *singleTile:true* tag in the layer specification. This will perform faster for this use case than tiled layers. Tiled data is provided by all the commercial maps (Google, MS) or can be rendered and stored/cached via TileCache from you own WMS sources. In that use case this will be much faster since the tiles already exist on the server and don't have to be produced on the fly by a rendering engine with each new map request. The OL website has resources to learn about the API and also a nice collection of examples on how to use or setup functionalities with OL. The list of examples can be found here: OpenLayers 2 and OpenLayers 3.

4.1.1 Some Important OpenLayers Objects

OpenLayers.Map the OL map object

The OpenLayers API architecture uses an object oriented approach. The following section will introduce a few of the main components that make up a typical OL viewer web page. The main component in OL is the **map object**. Once the map object is defined, other components, such as data layers and tools (map controls) can be added to it.

The following JavaScript snippet (taken from ol_map_simple.html) shows a simple definition of a map object defining the variable called **map** including the *options* variable as parameters. In this example the parameters include the map projection, map units, and map extent. Note that a JS function *window.onload* is used to initiate the OpenLayers objects when the page is first loaded in a browser. The live example is here.

```
var map;
var options = {
    projection: new OpenLayers.Projection("EPSG:3857"),
    units: "m",
    maxResolution: 156543.0339,
    maxExtent: new OpenLayers.Bounds(-13776237,5870705,-13270618,6177605)
};

window.onload = function(){
  map = new OpenLayers.Map( 'map',  options );
```

Map.Layer objects

The following section is defining a variety of map layer objects: Counties and Rails as WMS layers, and empty base layer, and two Google layers. The last line of JS code below adds the layer objects to the map (object).

```
  var Counties = new OpenLayers.Layer.WMS( "counties",
          "/cgi-bin/mapserv.exe?map=C:/class/data/mapfiles/wacounties_wms.map
               ", {layers: 'Counties', 'transparent': true}, {isBaseLayer:
               false, 'opacity': 0.7, 'visibility': false, singleTile:true} );
  var Rail = new OpenLayers.Layer.WMS( "rail",
          "/cgi-bin/mapserv.exe?map=C:/class/data/mapfiles/wacounties_wms.map
               ", {layers: 'Rail', 'transparent': true}, {isBaseLayer: false, '
               opacity': 0.7, 'visibility': true, singleTile:true} );
  var Cities = new OpenLayers.Layer.WMS( "cities",
          "/cgi-bin/mapserv.exe?map=C:/class/data/mapfiles/wacounties_wms.map
               ", {layers: 'Cities', 'transparent': true}, {isBaseLayer: false,
                'opacity': 0.7, 'visibility': false, singleTile:true} );
  var Uninhabited = new OpenLayers.Layer.WMS( "uninhabited",
            "/cgi-bin/mapserv.exe?map=C:/class/data/mapfiles/wacounties_wms.
                 map", {layers: 'Uninhabited', 'transparent': true}, {
                 isBaseLayer: false, 'opacity': 0.7, 'visibility': false,
                 singleTile:true} );

  var base_empty = new OpenLayers.Layer("No Background", {isBaseLayer: true,
       numZoomLevels: 20, 'displayInLayerSwitcher': true, basename: "empty"});
  map.addLayer(base_empty);
  var g_street    = new OpenLayers.Layer.Google("Google Streets"   ,{'
       maxZoomLevel':20} ); map.addLayer(g_street);
  var g_satellite = new OpenLayers.Layer.Google("Google Satellite" ,{type:
       google.maps.MapTypeId.SATELLITE, 'maxZoomLevel':20} );
```

```
map.addLayers([g_street,g_satellite,base_empty, Uninhabited,
    Counties]);
```

OpenLayers Control objects

In the code section below two map controls (tools) are added to the map. First the *LayerSwitcher* (to turn layers on and off) is added, then a second control *MousePosition* (enabling the display of the mouse cursor position in map coordinates) is defined and added to the map (last line of JS code below).

```
var bounds = new OpenLayers.Bounds(-13776237,5870705,
    -13270618, 6177605);
map.zoomToExtent(bounds);

map.addControl( new OpenLayers.Control.LayerSwitcher() );
mp=new OpenLayers.Control.MousePosition();

mp.displayProjection = new OpenLayers.Projection
    ("EPSG:3857");
map.addControl(mp);
}; // end bracket of 'window.onload' function
```

important map control objects

The OL API documentation can help to expand your knowledge about the API basics described in the paragraphs above. One important section of the API docs is the part about map controls. A lot of functionality is included in the OpenLayers.Control (map control) objects `http://dev.openlayers.org/docs/files/OpenLayers/Control-js.html`.

4.1.2 Commercial Layers in OpenLayers

integrate commercial map layers
Google
MapQuest
Bing

Commercial map layers such as those from Google, MapQuest and Bing (Microsoft) can be directly used in OpenLayers as *base* (background) layers for your map. Those layer are based on scale dependent tiles (small images) that OpenLayers (or other viewers) stitch together to provide an entire map. The idea behind this architecture that the transfer of the already existing (pre-rendered) tiles is faster than requesting a new image that is rendered (image file that is generated) on the fly by a mapping engine each time the map changes (for example in a pan or zoom request by a user).Some of the commercial map providers offer their own API that can be used stand alone without OpenLayers to make map. The benefit to use OpenLayers is being able to easily switch between base layers and the added comfort of the comprehensive OpenLayers API providing many tools to add and manipulate your own data. For some of those providers that also supply a mapping API we will need to include a reference to the JavaScript of the provider to enable the map layer to work as expected (Google, Bing) [1]. Note that for many cases those layers can be legally used without charge, however be aware that certain restrictions apply which may differ by provider. For example the Google terms of use indicate that the layers can be used in your maps (and in OpenLayers) free of charge, but when yo want to put the same map behind a password protection you will need to purchase a professional license to comply with the terms of use. Note that the Yahoo API was officially discontinued in 2011 and that consequently maps based on it with cease working in the near future. Regarding Google API version 2 of it required to apply for a map API key that needed to be referenced in your map page (see page 107). For mapping layers of Google API version 3 no key is needed and **the syntax also changes slightly**. MapQuest started in 2011 to base their map tiles entirely on data from Open Street Map project . On page 107 see code snippets on how to include Google v3, MapQuest, Open Street Map, and Bing layers. There are multiple maps rendered from open street map data such as one based on Mapnik and one focusing on suitable bicycle routes.

Google API

Open Street Map

4.1.3 Adding WMS data to your map

To use Google map tiles together with our own MapServer layers in OpenLayers we define the map projection as "Spherical Mercator" (that is the projection of the Google and other commercial tiled data sources). This is necessary because MapServer can re-project our data to any projection no matter what the source projection is (on the fly), but tiles offered by the tiled data sources mentioned above have a fixed map projection that we have to match to align the map tiles and our own data correctly. We set the projection in the general map definition:

```
PROJECTION
        "init=epsg:3857"
END
```

adding the projection to the epsg file

In order for MapServer to be able to decode this epsg code it has to be specified in the epsg file (that is used by Proj4). The epsg is a text file that stores map projections as a list of projection strings. So let's go ahead and add that projection to our epsg file (the file should be located in the c:
ms4w

[1] see page 107 for an example of an HTML page that includes such a reference

proj
nad directory). Basically the code has to be added to the file if it does not exist – best is as the first entry that speeds up MapServer to retrieve it. In Notepad++ add and save this line on top of the file:

```
# Spherical Mercator
<3857> +proj=merc +a=6378137 +b=6378137 +lat_ts=0.0 +
    lon_0=0.0 +x_0=0.0 +y_0=0 +k=1.0 +units=m +nadgrids=
    @null +no_defs  <>
```

SQL to add the Spherical Mercator projection to the PostGIS table spatial_ref_sys

In PostGIS similarly this is also used and all possible EPSG codes (here called SRID for Spatial Reference ID) are stored in the "spatial_ref_sys" table. We can add the SRID also to the spatial_ref_sys table (e.g. for bounding box re-projections in PostGIS from decimal degrees to Spherical Mercator) via SQL like this. Insert Google Spherical Mercator (EPSG 3857):

```
INSERT into spatial_ref_sys (srid,auth_name,auth_srid,
    proj4text,srtext) values (3857,'spatialreference.org
    ',3857,'+proj=merc+a=6378137+b=6378137+lat_ts=0.0+
    lon_0=0.0+x_0=0.0+y_0=0+k=1.0+units=m+nadgrids=@null
    +wktext+no_defs','PROJCS["unnamed",GEOGCS["
    unnamedellipse",DATUM["unknown",SPHEROID["unnamed
    ",6378137,0]],PRIMEM["Greenwich",0],UNIT["degree
    ",0.0174532925199433]],PROJECTION["Mercator_2SP"],
    PARAMETER["standard_parallel_1",0],PARAMETER["
    central_meridian",0],PARAMETER["false_easting",0],
    PARAMETER["false_northing",0],UNIT["Meter",1],
    EXTENSION["PROJ4","+proj=merc+a=6378137+b=6378137+
    lat_ts=0.0+lon_0=0.0+x_0=0.0+y_0=0+k=1.0+units=m+
    nadgrids=@null+wktext+no_defs"]]')
```

The Open Street Map (OSM) projection

The Open Street Map (OSM) projection is very similar to the Google Spherical Mercator projection and sometimes also called "Google Mercator". To add it to the epsg file:

```
# SR-ORG Projection 6627 - Open Street Map (OSM)
<6627> +proj=merc +lon_0=0 +k=1 +x_0=0 +y_0=0 +ellps=
    WGS84 +datum=WGS84 +units=m +no_defs <>
```

Insert into PostGIS:

```
INSERT into spatial_ref_sys (srid,auth_name,auth_srid,
    proj4text,srtext) values (96627,'sr-org',6627,'+proj
    =merc+lon_0=0+k=1+x_0=0+y_0=0+ellps=WGS84+datum=
    WGS84+units=m+no_defs','PROJCS["GoogleMercator",
    GEOGCS["WGS84",DATUM["WorldGeodeticSystem1984",
    SPHEROID["WGS84",6378137.0,298.257223563,AUTHORITY["
    EPSG","7030"]],AUTHORITY["EPSG","6326"]],PRIMEM["
```

```
Greenwich",0.0,AUTHORITY["EPSG","8901"]],UNIT["
degree",0.0174532925199433295],AXIS["Geodeticlatitude
",NORTH],AXIS["Geodeticlongitude",EAST],AUTHORITY["
EPSG","4326"]],PROJECTION["Mercator_1SP"],PARAMETER
["semi_minor",6378137.0],PARAMETER["
latitude_of_origin",0.0],PARAMETER["central_meridian
",0.0],PARAMETER["scale_factor",1.0],PARAMETER["
false_easting",0.0],PARAMETER["false_northing",0.0],
UNIT["m",1.0],AXIS["Easting",EAST],AXIS["Northing",
NORTH],AUTHORITY["EPSG","3857"]]');
```

Tip

Projection look-up made easy

There are two web sites spatialreference.org and epsg.io that are making it easier to look-up many map projections and display their definitions in multiple formats such as ESRI *prj files*, PostGIS insert statements, *Proj4 epsg codes*, MapServer map file definitions, and others.

4.1.4 OpenLayers Exercises

Viewing a basic Map in OL

1. Review the examples in the Appendix of this booklet
2. Create a new HTML page in Notepad++ (you can start with the file osgis/ol_map_simple.html as save it as osgis/firstmap.html, see the local class example live here)
3. Add additional *base layers* such as **Google Streets**, **Google Hybrid** and **Bing** to the map. You can review the syntax in alllayers.html for help, see the live example here.
4. Add two existing MapServer WMS layers to the OL map (e.g. rails and uninhabited land). Refer to osgis/ol_map_simple.html to see the syntax for adding a WMS layer. Make sure the layer is **not** configured as a *base layer* and that is switched off by default. The basic syntax of a WMS layer object in OL is documented here and has the parameters *name*, *url*, *params*, and *options*.
5. Add a MapServer legend to the page. You can use osgis/one_wms_layer.html as an example. To do this you can add a HTML image tag <img src="xy.jpg"> to the page and reference a GetLegendGraphic request to a MapServer WMS layer. You may want also to review the

syntax in the chapter about Web Map Services. Note how HTML <div> elements and CSS styles definitions are used to layout the page.

6. Optional and advanced: Review the *Code Listing for osgis/identify/map.html* in the back of this booklet on page 111 and add the identify feature functionality for one WMS layer of your choice to your map. Edit the file to enable identifying features in your WMS layer. View live example here.

4.1.5 OL Examples (version 2.13)

See also the more detailed list in the resources section on page 111 "*OL examples included on the class DVD*".

- Identify Features Example (map.html on DVD)
- Digitize Polygons Example (mapserver_wa_digitize.php and save_polygon.php on DVD and live example)
- Measure Distance and Area Example and control documentation
- Click Event Handler Example. This event can be used to trigger any action to write inside click event script. For example we could query PostGIS, retrieve feature attributes and open a pop-up or web page.
- Review alllayers.html from the class DVD as an example how individual Commercial Layers - Google, Bing, MapQuest - can be added to a OpenLayers map along with Open Street Map tiles.

4.1.6 Optimizing OpenLayers

Over the course of the last years the OpenLayers library grew and had a lot of new functionalities added to it. While this is great and allows to build more and more complex web application using the API, the library roughly doubled in size. Here are a couple of ways one can go about optimizing OL performance.

Apache HTTP compression

- A general approach for your web (mapping) application can be to use HTTP compression for Apache. More information on how to configure this here.

Custom built OpenLayers

- Another approach is to reduce the functionality of the OL library in a production environment to just the functionality needed and to strip everything else. In many cases this can result in a OL library that is 50% or more smaller than the standard OL (version 2) built. An article by Richard Marsden about building a custom OpenLayers library can be found here.

4.1.7 OpenLayers is also used as

- data viewer in Spatial Data Integrator (Spatial ETL)
- optional viewer in Mapbender
- the default map viewer in Django (a content management system)
- a data viewer in the web based GeoServer configuration interface

4.2 Using MapServer

In this class we are using MapServer in CGI mode via HTTP requests only (not MapScript)

Mapserv.exe is the CGI portion for the MapServer package. It handles user input and directs image creation or query requests. The program accepts input via either "GET" or "POST" methods and can be used in an interactive manner or as an image engine. The documentation is available online in the reference manuals and in PDF format MapServer manual download (700+ pages). Note that the system user that is running Apache (or your HTTP Server) needs read/write permissions for the log file to make this work. You may need to create an empty log file and set the correct permissions. On Linux this is usually the user called *www-data*. Another method to enable logging is by setting an environment variable MS_ERRORFILE (see the MapServer manual, Chapter 5, page 86).

Prerequisites to run MapServer

To run MapServer and successfully use it interactively in a browser, several prerequisites exist:

- HTTP server is installed and running ⟹ Apache2
- Apache configuration is setup correctly
  ⟹ Aliases, web directory, permissions
- If we are using a scripting language this has to be configured correctly ⟹ PHP installed , php.ini setup correctly
- Libraries MapServer is depending on are installed (several have to be compiled with MapServer). GDAL, OGR, Proj etc.

- Fonts, symbol files that are referenced in your map file need to exist and be located in the correct directory
- A temp directory for the map output needs to be specified

Note that windows fonts can be used with MapServer

Many of those prerequisites are already taken care of when we install a pre-configured package such as MapServer for Windows (MS4W).

4.2.1 Installing MS4W - MapServer for Windows

Installation instructions for MS4W [2] are available on the web

The paragraphs in the next section are quoted from maptools.org.

Extracting MS4W for the first time

Please read through the following instructions before starting your installation.

unzip the package to C:/ms4w

1. To install the MS4W .zip file, use a compression program (e.g. SevenZip) to extract the package at the root of a drive, e.g., drive C:. If successful, you should have a new directory named 'ms4w' at the root of the drive you chose (e.g. C:/ms4w).

Start Apache HTTP Server

2. Start your MS4W Apache Web Server by running /ms4w/apache-install.bat (at the command line or by double-clicking it). This file installs Apache as a Windows service (called "Apache Web Server") so that it starts whenever your machine is restarted. When executed, a DOS window should pop up with the following message:

   Installing the Apache MS4W Web Server service
   The Apache MS4W Web Server service is successfully installed.
   Testing httpd.conf....
   Errors reported here must be corrected before the service can be started.
   The Apache MS4W Web Server service is starting.
   The Apache MS4W Web Server service was started successfully.
   This means that Apache is running and installed as a service.

   Notes for MS VISTA and MS 7

   In order to run the apache-install.bat file in **Microsoft Windows Vista, and Windows 7and 8** follow these instructions:

   a) In Windows Explorer, go to the location of your cmd.exe file (C:/Windows/System32)

   b) Right-click the cmd.exe executable and choose **Run as Administrator**

[2] Please be aware that the MS4W package may be replaced over time with the new comprehensive package OSGEO4W and its download manager `http://trac.osgeo.org/osgeo4w/`

c) Navigate to your ms4w folder in the command prompt window and run apache-install.bat

Test Apache in your web browser http://localhost

3. To test that Apache is running properly, open your Web browser and find your local host Web service by entering one of the following URLs:
http://localhost or http://127.0.0.1 You should now see the main MS4W page in your Web browser. This gives you general information about your install along with configuration information. If this is your first time using MS4W it is very important that you review the listed "Features" installed within MS4W, and test them by selecting each link found on this page.

MS4W is installed!

4. Technically, at this point, MS4W is installed! However, as you may have noticed from the MS4W main index.html page, there are no applications running. What this means is that there are no Web applications like MapLab or Chameleon found within MS4W's Web-accessible directory, /ms4w/apps/. The MS4W-configured Web applications can be found on `http://maptools.org/ms4w/index.phtml?page=downloads.html` as separate zip files.

Optional web applications not used in this class

5. To, install these Web applications into /ms4w/apps/ all that is required is to download and unzip the Web application compressed file at the same root directory as MS4W (e.g., C:). We will be working for the purposes of this class with MapServer only. Thus the following details of this paragraph are for reference only. Two things should happen when uncompressing this file. First, the Web application directory should appear within /ms4w/apps/. Second, a new httpd_*.conf file should be added to /ms4w/httpd.d/httpd_*.conf. (The /httpd.d/ directory contains Apache configuration files that define which files on your computer/server are Web-accessible. For each Web application that you install, a new configuration file will be found.)

Configure Aliases for use by Apache ⟹ add "osgis"

6. The definitions of these Web-accessible directories are called Web Aliases. In order to activate a Web Alias you must restart Apache. To test your latest installed application, go to the MS4W main index.html page (i.e., http://localhost/). In the applications section you should now find a link to the application you just installed. Select the link to the recently installed application to see if it is

configured correctly. Another option is find the Web Alias in the Apache configuration file [3] for your application and call it from your Web browser directly.

7. To enable the use of a number of utility programs that usually are distributed with MapServer, the environment path (for your operating system) to the /ms4w/Apache/cgi-bin directory needs to be set (more information on page 47). You can

    - set the path manually in your Environment Variables permanently or
    - run the batch file /ms4w/setenv.bat to include this directory in your path (temporarily until next reboot)

Set environment variable path for MapServer utility programs

Installation of Notepad++

syntax highlighting for MapServer .map files

- Notepad++: software/notepad/npp.xyz.Installer.exe
- Setup syntax highlighting for MapServer .map files

- **windows 7 and earlier**
  ⟹ Copy **userDefineLang.xml** to
  C:/Documents and Settings
  thecurrentuser*/Application Data/Notepad++/*
  ⟹ Copy **mapfile.api** to
  InstallationPath/Notepad++/plug-ins/APIs

- **windows 8**
  ⟹ Copy **userDefineLang.xml** to
  C:/Users/
  thecurrentuser*/AppData/Roaming/Notepad++/*
  ⟹ Copy **mapfile.api** to
  InstallationPath/Notepad++/plugins/APIs/

2 Tips for using Notepad++:

- Press CTRL+Space for auto completion.
- Make use of the effective column edit mode - using Alt + Mouse dragging.

[3] c:/ms4w/Apache/conf/httpd.conf

4.2.2 Configuration of MapServer

- The CGI interface can be tested at the command line by using the "QUERY_STRING" switch, such as:
  mapserv "QUERY_STRING=map=c:/class/data /mapfiles/wacounties_wms.map&mode=map"

- To save the output into an image file, use the pipe command such as:
  mapserv -nh "QUERY_STRING=map=c:/class/data /mapfiles/wacounties_wms.map&mode=map" > test.png

Debugging

It can be very useful to switch on debugging for MapServer and write the output to a log file. One method to do this is to add two tags to your map file:

```
CONFIG "MS_ERRORFILE" "c:/tmp/mapserver.log" # path to
    log file
DEBUG 5  # debug level 0—5 (5 is most output)
```

Configuration of MapServer output is done via a map file

Configuration of map output with MapServer is done in the map file. The map file is not an XML file (however it probably would be one if MapServer was invented today). It uses tags similar to XML to configure the output and functionalities of MapServer. The Map file online references are located here:

MapServer reference guides

Official MapServer site
http://mapserver.org/mapfile/index.html#mapfile

be aware of map file syntax changes for MapServer version 6

Note that in MapServer version 6 some of the map file syntax and data handling by MapServer changed from previous versions. This is especially important when using example map files from earlier MapServer versions that can be found in forums or elsewhere on the internet. To review the changes consult the migration guide http://mapserver.org/MIGRATION_GUIDE.html#mapserver-5-6-to-6-0-migration.

Example of a map file

A basic map file

```
MAP #Start of map file (wacounties.map)
NAME "Washington Counties"
EXTENT 600000 —800000 2750000 1000000 # bounding box (map
      extent)
SIZE 600 300                          # size of output
     map in pixels
PROJECTION
```

```
 "init=epsg:2285" # Map Projection WA State Plane N in
      feet
END
  LAYER # Data Layer object
    NAME Counties    # name of layer used as a reference
         by MapServer
    TYPE POLYGON     # spatial type
    STATUS ON   # status (on/off/default)
    DATA "c:/class/data/layers/counties2008"  # input
         data source (shape file in this case)
    CLASS            # classification
      STYLE
        COLOR 255 128 128
        OUTLINECOLOR 96 96 96
        WIDTH 1
      END
    END  # Class END
  END    # Data Layer END
END      # Map File
```

Create map images on the desktop: shp2img

map images on the desktop shp2img

To create a map image from a map file on the desktop shp2img can be used. The output can either be PNG or GIF. This is useful to test your map file. If all goes well an image will be returned. If the image cannot be created an error message on the command line will refer to a line number in the map file. More information at http://www.mapserver.org/utilities/shp2img.html.

```
shp2img −m mapfile [−o image] [−e minx miny maxx maxy] [−
     s sizex sizey]
          [−l "layer1 [layers2 ...]"] [−i format]
          [−all_debug n] [−map_debug n] [−layer_debug n]
               [−p n] [−c n] [−d
         layername datavalue]
 −m mapfile: Map file to operate on − required
 −i format: Override the IMAGETYPE value to pick output
      format
 −o image: output filename (stdout if not provided)
 −e minx miny maxx maxy: extents to render
 −s sizex sizey: output image size
 −l layers: layers to enable − make sure they are quoted
      and space
    separated if more than one listed
 −all_debug n: Set debug level for map and all layers
 −map_debug n: Set map debug level
```

```
—layer_debug layer_name n: Set layer debug level
—c n: draw map n number of times
—p n: pause for n seconds after reading the map
—d layername datavalue: change DATA value for layer
```

For example to create an image with the Counties and Rail layer in *wacounties_wms.map*:

```
shp2img —m c:/class/data/mapfiles/wacounties_wms.map
—l "Counties Rail" —o counties_rail_map.png
```

4.2.3 MapServer Exercises

4.2.3.1 Making a basic Map

1. Review the basic map file wacounties.map and create a png map image output using shp2img
2. Open the file ../data/map files/wacounties.map in Notepad and add the layers:
   citynames, rails, and uninhabited areas
3. Review your configuration using shp2img. Troubleshoot any errors
4. Use the reference guides and sample map files (in the end of this booklet) to find the correct syntax for classification of layers by attributes.
5. Classify one of the layers you added to *wacounties.map* using the **EXPRESSION** map tag assigning different colors for its attributes (or attribute ranges). Review one example for classification of attribute ranges using the EXPRESSION tag in the map file starting on page 100.

4.2.3.2 Making your own Map

reference guides and sample map files for help

Use the MapServer reference and sample map files in this guide for help. Review your progress periodically using the shp2img utility.

1. Either use the map file created in the above or create a new one. You may use your own data if desired.
2. Add at least five data layers and classify their cartographic representation using class tags.
3. Add scale dependency to the layers in the map file (MAXSCALE/MINSCALE or MAXDENOMSCALE/MINDENOMSCALE) so that they are only available at certain defined scales

4. Use scale dependency for a layer to change the cartographic output for small scales (overview) and large scales (detailed) for the map output.

5. Add labels to the city layer (or another layer you have defined)

6. Add a tif image file to your map using the RASTER type layer. You may use any of the tif files located in the *data/layers/catalog/topography* directory. An example of a RASTER Layer (*Topography*) can also be found in the map file starting on page 100

7. Add a tiled vector layer as data source to the map using the TILEITEM and TILEINDEX tags. The *data/layers/catalog* directory contains *tiled* shape files and their respective tile index shape files (containing the boundaries of the cut shape files) for lakes and rivers on multiple scales.

8. Review how you can tile shape files (and create the tile index files) yourself using the utilities shp2tile[4] and tile4ms[5] (see page 47. One example can be found in the map file *data/mapfiles/map_file_library/alliance_base_layers.map* for the *50k Tiled Layer Rivers_and_Streams*.

4.2.4 Additional Topics

Review the online documentation for these interesting topics:

- Map Templates
- Query Templates
- Variable Substitution

variable substitution in MapServer templates

A simple way to embed your map output in a web page are MapServer templates. This is an example "Help me a spider" of a simple HTML file and a respective map file (quoted from the book by Bill Kropla (2005): Beginning MapServer: Open Source GIS Development -Chapter two). Note that MapServer can replace variables that are embedded in brackets[] during run time. In this case MapServer will replace the [**img**] variable and return the rendered image.

data/mapfiles/helpmespider.html:

[4] cut a big shape into a grid of adjacent shape files

[5] create tile index shapefile for use with MapServerŠs TILEINDEX feature. This will create a shapefile of rectangular extents of all shapefiles listed. Note that the utility *ogrtindex* of the OGR-package has similar functionality

```
<!-- MapServer Template -->
<html>
<head> <title>MapServer Easy Map</title></head>
<body>
    <form method=POST action="/cgi-bin/mapserv.exe">
        <input type="submit" value="Click Me">
        <input type="hidden" name="map" value="c:/class/
            data/mapfiles/helpmespider.map">
    </form>
    <IMG SRC="[img]" width=800 height=400 border=0>
    <p>[version]</p>
</body>
</html>
```

data/mapfiles/helpmespider.map:

```
MAP #Start of map file
NAME "Washington Counties"
EXTENT 630000 -540000 2700000 780000 # bounding box (map
    extent )
SIZE 600 300 # size of output map in pixels
        WEB
                TEMPLATE "/ms4w/Apache/htdocs/osgis/
                    helpmespider.html"
                IMAGEPATH "/ms4w/tmp/ms_tmp/"
                IMAGEURL "/ms_tmp/"
        END
        LAYER # Data Layer object
        NAME Counties # name of layer used as a reference
            by MapServer
        TYPE POLYGON # spatial type
        STATUS DEFAULT # status (on/ of f / default )
        DATA "c:/class/data/layers/counties2008" # input
            data source (shapefile in this case)
                        CLASS # classification
                        OUTLINECOLOR 100 100 100 # color
                            for outline boundary
                        END # Class END
        END # Data Layer END
END # Map File END
```

4.2.5 Publishing Web Map Services (WMS) with MapServer

One or more layers of a map file can be published as part of a WMS

To publish a layer or layers as a WMS some additional information is required. One or more layers of a map file can be published as part of a WMS. Depending on the settings, the layers can be accessed by a WMS client (e.g. ArcMap or uDig) independently or as an entirely configured map. A WMS will give back an image if it gets the appropriate **GetMap** request. Layers configured as DEFAULT will always be output to any incoming request even if they were not requested. Below is an example of a **GetMap** request asking for

GetMap request example

- a map in **PNG** format
- with the layer **States**
- in projection EPSG 2285 (Washington State Plane North)
- with bounding box (extent) 630000,-540000,2700000,780000
- in 400 by 300 pixels size

`http://terra2.terragis.net/cgi-bin/mapserv?map=/var/www/sites/mapdata/projects/alliance/alliance_background.map&version=1.1.1&service=WMS&request=GetMap&layers=States&srs=EPSG:2285&bbox=630000,-540000,2700000,780000&format=image/png&width=400&height=300&styles=default`

The OGC standard defines the type of requests that a WMS supports. The following requests are defined by the standard:

- GetCapabilities `http://<computername>/mapserver?map=../demo.map&VERSION=1.1.1&REQUEST=getCapabilities&SERVICE=wms`
  $\Longrightarrow$ What can the WMS offer ? Returns service-level metadata in XML format
- GetMap (example above) $\Longrightarrow$ returns a map with well-defined geographic and dimensional parameters
- getFeatureInfo (optional)
  $\Longrightarrow$ returns information about features (identify attributes)
- getLegendURL (optional)
  e.g. `http://terra2.terragis.net/cgi-bin/mapserv?map=/var/www/sites/mapdata/projects/alliance/alliance_boundaries.map&version=1.1.1&service=wms&request=getlegendgraphic&layer=Tract_Boundaries&format=image/png`
  $\Longrightarrow$ returns a legend graphic

This figure illustrates a client-server architecture for geospatial web services (geoservices). Green color represents read and write paths. Dotted arrowed lines indicate mostly read-only data flow (this figure is freely available from Wikimedia Commons).

client-server architecture for geospatial web services

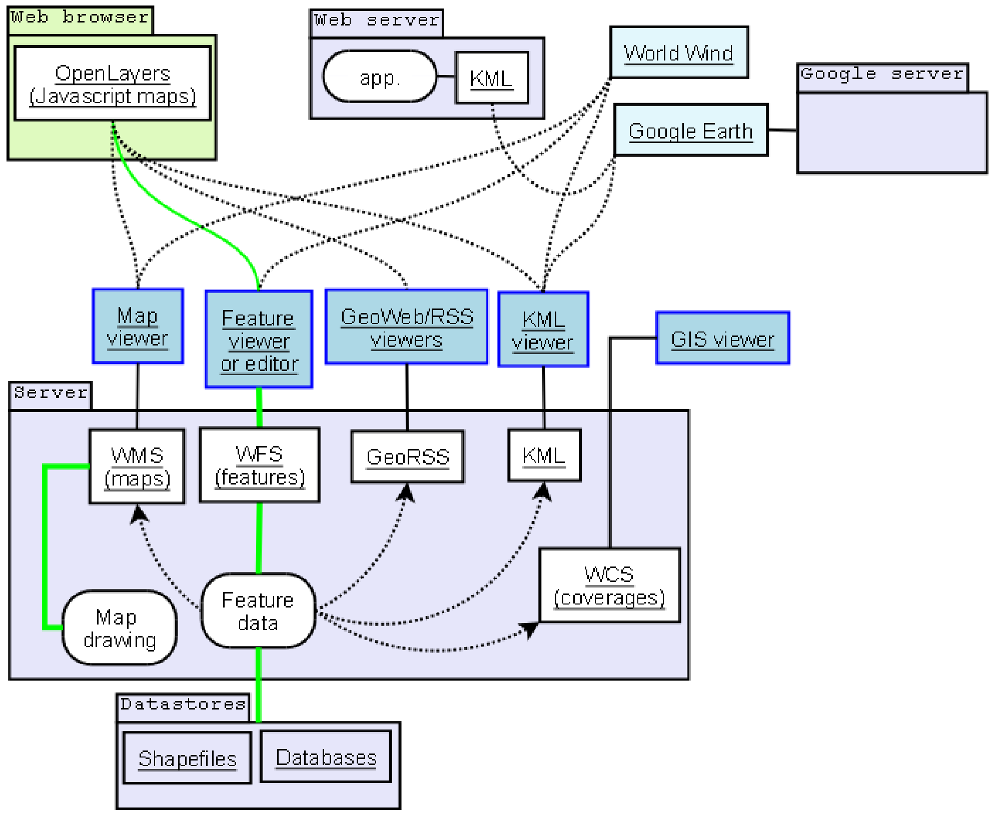

Figure 6: Client-server Architecture for geospatial web services

To change a regular layer in a map file into a WMS layer we need to define several METADATA tags for it (see example below). The wms_srs tag defines the output projection(s) that are provided by MapServer and that a client (e.g. OpenLayers) can request:

WMS metadata tags

```
METADATA
    "wms_title" "PrecinctTargets"      # Name of WMS
    "wms_srs" "epsg:3857 epsg:4326" # Spherical Mercator
         and Geographic Projection
    "wms_feature_info_mime_type" "text/html" #Format of
        Query (GetFeatureInfo requests)
     "ows_enable_request"    "*"  # needed in MS 6 and
         higher to enable WMS requests
END
```

Note that with MapServer you need to use the MapServer layer name (defined in the map file under LAYER, NAME to request it in a HTTP request and not with the wms_title as you might expect). "*The latter is used to produce the title element for the layer in a WMS GetCapabilitites request and is usually displayed by WMS clients as the human-readable caption of the layer. The MapServer LAYER NAME is mapped to the <Name> element in the WMS GetCapabilities which is the unique name/id of the layer, this is the identifier by which client and server software refer to this layer in GetMap and other requests*" (Daniel Morissette communication 2009). The MapServer documentation has more details about the use of WMS with MapServer: http://mapserver.org/ogc/wms_server.html.

in WMS request use the MapServer layer name - defined in the map file under LAYER, NAME

4.2.6 WMS Exercises

Publishing your own WMS

1. Use the map files written during the earlier MapServer exercises and publish the layers as Web Map Services

2. Verify your results via HTTP requests in a web browser (examples for requests are in the section about WMS standards)

3. Try different kind of requests - **GetMap** and **GetLegend** and save the results as files on your laptop.
   Use the reference guides and this booklet to find the correct syntax

4. Install any or all of the desktop GIS systems on your laptop (gvSIG, QGIS, uDig) and open your WMS on the desktop.

4.2.7 MapServer Performance Tips

MapServer Performance Tips

A good resource to find more information about tuning the performance of MapServer is the reference at `http://www.mapserver.org/optimization/index.html#optimization`

4.2.7.1 Tuning your map file for performance:

Use inline projection parameter definitions (*spelled out* parameters) in place of EPSG codes. If you want to use EPSG codes, remove all unneeded projection definition records from the Proj4 database. Or put the most used on top of the file.

For every layer in a map file that has a status of ON or DEFAULT, MapServer will load that layer and prepare it for display, even if that layer never gets displayed ⟹ Switch rarely used layers off (don't use DEFAULT for them).

4.2.7.2 Optimizing the performance of vector data sources

Splitting your data (use of filters is slower) with ogr2ogr utility (select on certain features from a data source, and save them to a new data source).

Shapefiles

Use shptree to generate a spatial index on your shapefile. This is quick and easy ("shptree foo.shp") and generates a .qix file. MapServer will automatically detect an index and use it. In addition to using Tileindex the data can at the same time also be indexed with shptree.

Use the sortshp utility This reorganizes a shapefile, sorting it according to the values in one of its columns. If you're commonly filtering by criteria and it's almost always by a specific column, this can make the process slightly more efficient.

PostGIS

Add indexed primary key
ALTER TABLE table ADD PRIMARY KEY (gid);

Spatial indexing (GIST index)
CREATE INDEX table_the_geom ON table (the_geom) USING GIST;

Reorganization
CLUSTER the_geom ON table;

Do not close DB connection by default
PROCESSING "CLOSE_CONNECTION=DEFER"

Maximum Image size influences the time needed for map rendering. Default is 2048. This can be increased by setting in the map file *MAXSIZE [integer]* in pixels.

4.2.8 Tools to work with MapServer

Most MapServer distributions come with a number of utility programs (see table below). To run the mapserv.exe utilities, the environment path to the /ms4w/Apache/cgi-bin directory must be set. You can

- set the path manually in your Environment Variables or
- run the batch file /ms4w/setenv.bat to include this directory in your path

For more information read the online reference guide at http://www.mapserver.org/utilities/.

MapServer utility programs

Additional utilities are included with MS4W in the *../m4w/tools/shapelib* directory. The tools coming with *shapelib* provide tools to work with shapefiles (read/write/update) and to write your own C programs. To mention one of them *shprewind* is a utility that can correct the winding order (sequence of vertices) in a shapefile, and can be used to repair defective shapefiles. Another handy tool is *shp2tile* that divides a (large) shapefile into multiple smaller tiled shapefiles. For more information read the user guide at http://shapelib.maptools.org/shapelib-tools.html. The GDAL utilities provide tools to manipulate raster data. To split large raster files into tiles the python utility *gdal2tiles* comes in handy. From the gdal homepage: "*This utility generates a directory with small tiles and metadata, following OSGeo Tile Map Service Specification. Simple web pages with viewers based on Google Maps and OpenLayers are generated as well - so anybody can comfortably explore your maps on-line and you do not need to install or configure any*

divide large shapefiles into a set of smaller "tiled" shapefiles

Table 12: MapServer utility programs

Utility name	description
legend	create legend
msencrypt	encrypt encryption key for connection parameters
scalebar	create scalebar
shp2img	create mapoutput
shptree	create quadtree-based spatial index for a shapefile (a .qix file)
shptreevis	view quadtree quadrants that are part of a .qix file
sortshp	sort the records of a shapefile based on a single attribute column (ascending/descending order)
sym2img	create dump of symbol file in PNG or GIF format
tile4ms	create tile index shapefile for use with MapServer's TILEINDEX feature. This will create a shapefile of rectangular extents of all shapefiles listed

special software (like MapServer) and the map displays very fast in the web browser. You only need to upload generated directory into a web server." *MapTiler* is a graphical interface for the *gdal2tiles* utility http://www.maptiler.org/.

Tools to create MapServer configuration files

map files can be created manually or using a tool

You can either write your map file manually using your favorite text editor (e.g. we have seen Notepad++ has syntax highlighting support, Textpad http://www.textpad.com/ syntax file: http://www.textpad.com/add-ons/files/syntax/map_40.zip, and UltraEdit (which itself is not free however). The utilities listed below can help you to write and manage map files:

4.2.9 Notes about MapServer

The following paragraphs are a short collection of handy notes about MapServer and by no means are intended to represent a complete guide to using MapServer. You are encouraged to explore by yourself and revert to the comprehensive MapServer

Table 13: Utility programs for creating MapServer configuration files

Utility name	description
MXD2map	is a Java based command ine utility to convert ArcGIS documents (.mxd) files to .map files. Download from http://www.mxd2map.org/index.html
AveiN! and AMeiN!	are two utility programs for ArcView 3 and ArcMap respectively that allow you to create a map and to export the result as a .map MapServer configuration file. AMeiN! translates into "ArcMap einfach ins Netz!" which is German for something like: "Loading ArcMap projects into the web made easy!". Download from http://sourceforge.net/projects/avein/
QGIS 2.X	can export a QGIS project as a .map file with the RT MapServer export plug-in (install via OSgeo4W as a python MapScript installation is needed)
Scribe	A set of utilities (GUI and Python scripts) that facilitate the creation of MapServer configuration files. More information can be found on the Github page and in initial article.

manual (on DVD) and also available on www.mapserver.org.

Migration from older versions

migrating to new MapServer versions

With each new release of MapServer new features will likely be added to it and bugs fixed, however with mayor version jumps (e.g. from 5.6 to 6.0) there will likely (unfortunately) be some changes to the map file syntax. New map file tags will be introduced and old ones can be replaced and deprecated. Map files obtained from the Internet or other sources can be of great help to build a cartography map file library for yourself. When you are using such map file with newer MapServer versions it will be a good idea to read the migration guide that is published in the MapServer web site. Tis way you can find out about potential changes that might be required to have your map file working as expected and which changes to your map file might be required. For version 6 (and for earlier versions) the document is located at http:

//mapserver.org/MIGRATION_GUIDE.html#migration.

MapServer Image Rendering Options

cartographic output configuration for MapServer

MapServer includes a variety of options for producing cartographic output (generating an image file such as jpg, png or gif formats for example). Starting with MapServer version 5 a new rendering engine called AGG (*Anti Grain Geometry* http://www.antigrain.com) was included. Earlier versions of MapServer had only the 'GD' rendering available which has been removed in version 6 of MapServer. With AGG in newer MapServer versions all output is antialiased [6] which enables very fine cartographic output. Some symbols such as cartographic lines (that where needed to enable anti aliasing in earlier versions of MapServer) are now deprecated (no longer supported). For more information see http://mapserver.org/output/agg.html#introduction.
Below is an example for a fairly nice map output configuration balancing rendering time , file size and cartographic quality. Another good comparison of map rendering settings and out for MapServer can be found at http://linfiniti.com/2010/03/comparing-renderers-in-mapserver.

```
OUTPUTFORMAT
 NAME 'AGG_Q'      # arbitary name, call in the map file
 DRIVER AGG/PNG    # (see below)
 IMAGEMODE RGBA
 TRANSPARENT OFF
 FORMATOPTION "INTERLACE=OFF"     # for tilecache this
      needs to be set to off
 FORMATOPTION "QUANTIZE_DITHER=OFF"
 FORMATOPTION "QUANTIZE_COLORS=256"
 MIMETYPE "image/png" #
END
```

To use the option above add to your map file in the general MAP tag

```
IMAGETYPE AGG_Q
```

[6] On Wikipedia states '*Font rasterization is the process of converting text from a vector description (as found in scalable fonts such as TrueType fonts) to a raster or bitmap description. This often involves some anti-aliasing on screen text to make it smoother and easier to read*' see http://en.wikipedia.org/wiki/Font_rasterization

Using True Type Fonts in MapServer on Windows

using windows fonts with MapServer

On many windows operating system versions you can find (true type) fonts (with the *.ttf file extension) on the file system at c:\Windows\Fonts\verdana.ttf. Those fonts can be used by MapServer for rendering labels (or even for using font characters as map symbols). In order to use the files MapServer will need to know about the location when rendering. This information can be indicated in the map file as the location of a text file that lists the fonts you are intending to use and their location (see syntax below). For example see the content of such a file *list.txt* below.

```
FONTSET "fonts/list.txt"
```

If the fonts are in the same directory (copy and list only the ones that you are really always using) the content of the the text file **list.txt** could look as shown below to enable fonts *verdana*, *verdana-italic*, and *wingdng3* (a windows font with many simple symbols)

```
verdana        verdana.ttf
verdana-italic        verdanai.ttf
wingdng3 WINGDNG3.TTF
```

4.3 Using PostGIS

When to use a spatial database instead of files

One consideration in the beginning: When to use a spatial database instead of files ? Basically a database should only be used in particular use cases:

- editing (multiple users)
- unified storage and access
- bulk processing

Prequisites : PostgreSQL and PostGIS installed

4.3.1 Installing PostGIS

PostGIS brings the power of spatial operations to PostgreSQL

Chapter two of the document "Introduction to PostGIS" (in the workshop materials: Postgis-introduction.pdf) outlines the installation of PostgreSQL and PostGIS. Instead of PostgreSQL version 8.0 in our workshop we are installing newer versions of PostgreSQL and PostGIS accordingly. Note that there where considerable changes from PostGIS version 1.5.X to PostGIS 2.X that also affect the installation process. In the sections below the PostGIS version to which they apply is indicated. In our workshop exercises we will create a database called "osgis" instead of "BC" (as named in the document "Introduction to PostGIS").

- Install PostgreSQL
- Install PostGIS
- Create plpgsql language
  on the SQL console: createlang plpgsql mydb

Changes from PostGIS 1.5.X to versions 2.X

Some highlights of the new functionalities in PostGIS 2.0 and up include raster data support (storage and spatial and analysis functions), comprehensive support for handling 3D data with surfaces and relationships, and the introduction of topology for vector data. Raster files (such as tif files e.g.) can be loaded into the data base using the command line utility raster2pgsql which has similar syntax as shape2pgsql for loading ESRI shapefiles. Raster data can stored be used in two ways with PostGIS - *inside* and *outside* the data base. Inside stored raster are loaded into the database as a *blob*, whereas *out-db* rasters are images located on eh file system and referenced in a table from within the database (see -R switch in the command line utility reference). This workshop will not cover details of working with PostGIS rasters.

Note that to enable deprecated functionalities in PostGIS 2.X (database functions available in prior versions of PostGIS but not by default in PostGIS 2.X) you can run specific SQL queries in order to enable those. This might be be relevant especially if importing data from a PostGIS 1.5 system into PostGIS 2.X after an upgrade (in order to not to have to rewrite many of the functions used in your application).

```
# change to SQL script directory
cd C:/Program Files/PostgreSQL/9.3/share/contrib/postgis-2.0/
# enable legacy functions in PostGIS 2.X
psql -d osgis -p 5432 -f legacy.sql
```

Setup of PostGIS versions 1.5.X (and older)

The initial step will always be to create a new database. This can be accomplished by either

using PgAdmin (the GUI based administration tool)

on the command line: *createdb osgis -U postgres*

In order to load and enable all PostGIS functionality in PostgreSQL we need to run the following two SQL scripts:

Loading PostGIS functions, casts etc into the db
c:/Program Files (x86)/PostgreSQL/9.3/share/contrib/postgis-1.5/postgis.sql

Loading the spatial reference table into PostGIS
c:/Program Files (x86)/PostgreSQL/9.3/share/contrib/postgis-1.5/spatial_ref_sys.sql

Instead of running these scripts above we also could create a spatially enabled database from a template that has the tables and functions already loaded.

Setup of PostGIS versions 2.X (and newer)

Again the initial step will be to create a new database. This can be accomplished by either

using PgAdmin (the GUI based administration tool)

on the command line: *createdb osgis -U postgres*

Starting with version 2.0 PostGIS is a regular Extension of PostgreSQL and can be installed in the same way as other additions to the database as follows:

Install PostGIS into a database on the command line
CREATE EXTENSION postgis;

Install topology support and functions
CREATE EXTENSION postgis_topology;

Install tiger data based geocoder
CREATE EXTENSION postgis_tiger_geocoder;

Enable fuzzy string match functions for geocoder
CREATE EXTENSION fuzzystrmatch;

4.3.2 Interacting with PostGIS

There are at east two options to interact with PostGIS. One can either use the command line utilities from a DOS prompt, or the Administration tool pgAdminIII that comes with PostGIS. For big data sets it is advisable that we use the command line since that can handle larger datasets than pgAdmin seems to be able to digest.

PostGIS - command line

There are manuals covering this topic available so we list here some examples only:

Creating a database createdb osgis -U postgres

Deleting a database dropdb osgis -U postgres

connecting to a db
psql -U postgres -d osgis
after that any sql or psql command can be used

psql command to list all tables \dt

psql command list all column of table counties2008
\d counties2008

Running SQL from file
-U postgres -d osgis -f thepath/myfile.sql

PostGIS - Simple Spatial SQL Queries

Some of these examples are taken from the sql file postgis-introduction.sql

```
-- Distance Query

create table points ( pt geometry, name varchar );
insert into points values ( 'POINT(0 0)', 'Origin' );
insert into points values ( 'POINT(5 0)', 'X Axis' );
insert into points values ( 'POINT(0 5)', 'Y Axis' );
select name, AsText(pt), Distance(pt, 'POINT(5 5)') from points;
drop table points;

--Creating a spatial index

create index counties2008_gidx on counties2008 using gist (the_geom);

--Intersection

select NAME from counties2008 where counties2008.the_geom &&
    transform(((setsrid((MakePoint(-122.206834, 47.611421)),4326)))
    ,2285) and intersects (counties2008.the_geom,transform(((setsrid
    ((MakePoint(-122.206834, 47.611421)),4326))),2285));

--Select one spatial feature and reproject:
select astext(transform(the_geom,4326)) from counties2008 limit 1;

-- reproject two points from geographic (SRID 4326) to spherical
    Mercator projection (SRID 3857) and output as test
select astext(transform((SETSRID(Makepoint(-88.2,37.7),4326)),3857)),
     astext(transform((SETSRID(Makepoint(84.6,41.8),4326)),3857));
```

4.3.3 pgAdmin - Administration of PostGIS

PostgreSQL database connection parameters

Connecting to a PostgreSQL database in pgAdmin:

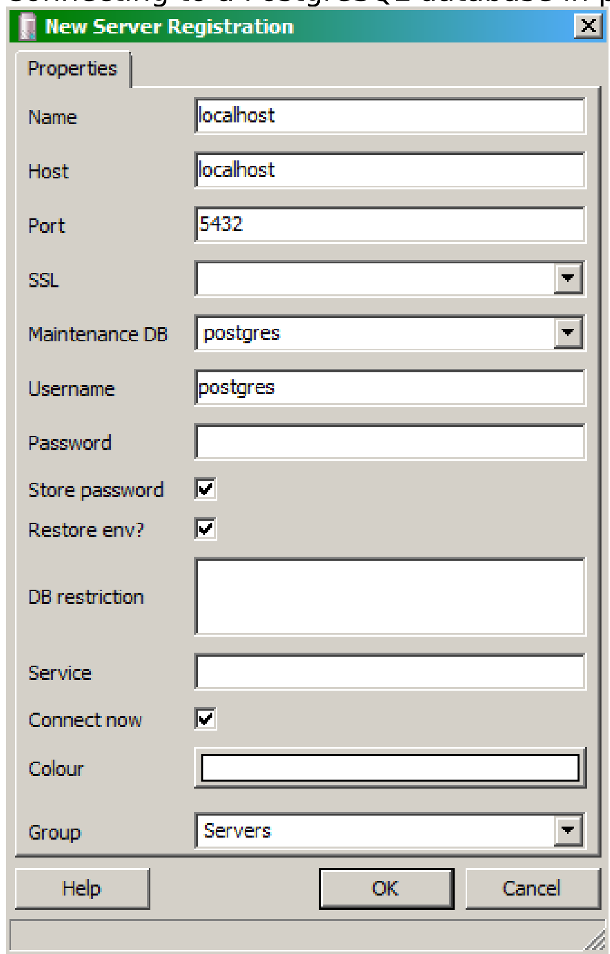

Figure 7: pgAdmin - Connecting to a DB Server

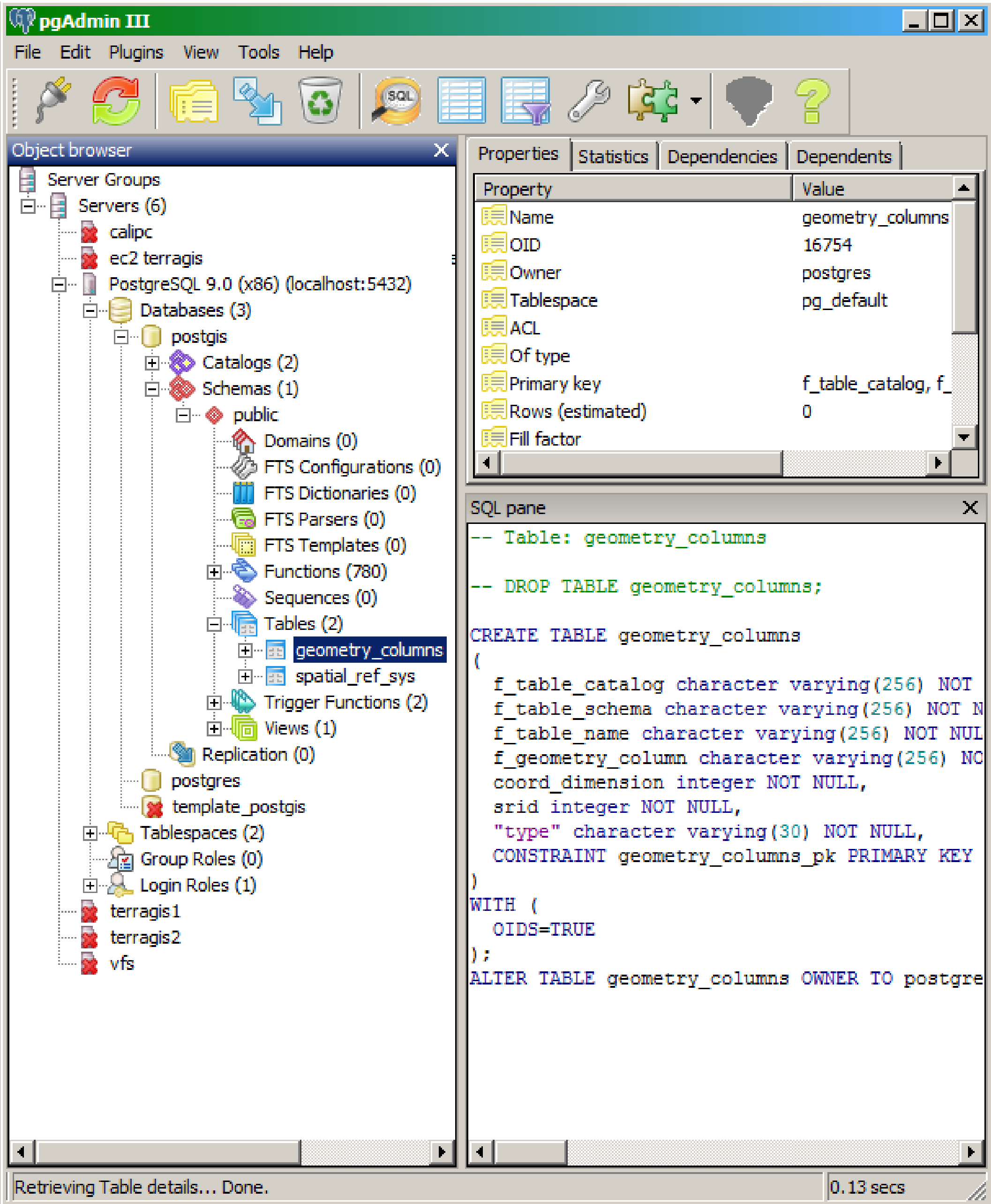

Figure 8: pgAdmin - Administration Tool for PostgreSQL

4.3.4 Utilities for PostGIS

PostGIS - Import and Export

import and export utilities shp2pgsql and pgsql2shp

import and export of shapefiles

Two utilities that come with PostGIS allow the import and export of shapefiles from and to PostGIS. Using shp2pgsql one can convert a shapefile into a SQL statement that can be loaded into PostGIS. Using pgsql2shp, a PostGIS layer can be exported and written to a shapefile.

Located in
c:/Program Files (x86)/PostgreSQL/9.3/bin/shp2pgsql.exe

For example to convert the shapefile IN_2008.shp (projection is decimal degrees - SRID 4326) and write to a SQL file "in_2008.sql" use this command (-i option is to use short integers):

shp2pgsql -i -s 4326 IN_2008.shp in_2008 > in_2008.sql

Now to load the data into PostGIS either copy the contents of in_2008.sql into the SQL window of pgAdmin and run or run the SQL from the command line:

-U postgres -d osgis -f thepath/in_2008.sql

importing formats other than shapefile

In order to load GIS data sources other than shapefiles the ogr2ogr utility can be used (see the table in the resource section for supported data formats). Another option to import data into PostGIS is the **OGR Converter Tool**, a plug-in that you can install with QGIS). This is an example of loading a dataset from an ESRI Personal Geodatabase into PostGIS using ogr2ogr on the command line:

```
ogr2ogr -f "PostgreSQL" PG:"host=localhost user=postgres
port=5432 dbname=postgis_in_action password=mypassword"
gadm_v0dot9.mdb -lco GEOMETRY_NAME=the_geom
-where "ISO='USA'" -t_srs "EPSG:2163" -nln "us.admin_boundaries"
gadm
```

Loading data from a file into PostGIS and making them spatial

The following work flow is an example to create a table in PostGIS, to load data into the empty table and then converting it into a spatial data set.

```
-- Creating and empty table called wa_voters via SQL
CREATE TABLE wa_voters
(
  house_number varchar(20),
  predir varchar(6),
  street_name varchar(50),
  postdir varchar(20),
  city varchar(50),
  state varchar(10),
  zip varchar(12),
  latitude float8,
  longitude float8,
  county_code varchar(8),
  ward varchar(12),
  precinct_code varchar(40),
  precinct_name varchar(40),
  code int2,
)
WITH OIDS;
ALTER TABLE locations OWNER TO postgres;


--Load data with the copy command
copy wa_voters from '/mnt/storage/wa_voters.txt';

-- Create spatial features from the new data:
-- To add a geometry column (only really needed for PostGIS 1.5 and
     earlier, but also can still be used in PostGIS 2.X !):
select AddGeometryColumn('','wa_voters','the_geom', 4326,'POINT',2);

-- when using PostGIS 2.0 and up one can use instead a column for the
      geometry in the table definition or add the column subsequently
     :
ALTER TABLE wa_voters ADD COLUMN the_geom geometry(Point,4326);


-- Update new column with features generated by the Makepoint
     function, with EPSG (SRID) 4326 (that's decimal degrees)
update wa_voters set the_geom = SETSRID(Makepoint(longitude, latitude
     ),4326);
```

```
--Create a spatial index (very IMPORTANT) on the geometry column:
CREATE INDEX wa_voters_gidx ON wa_voters USING gist(the_geom);

-- create sequence (for unique id field):
CREATE SEQUENCE wa_voters_gid_seq

--Add serial Column with unique id called "gid" (also updates all
    existing fields)
ALTER TABLE wa_voters ADD COLUMN gid serial;
ALTER TABLE wa_voters ALTER COLUMN gid SET STORAGE PLAIN;
ALTER TABLE wa_voters ALTER COLUMN gid SET NOT NULL;
ALTER TABLE wa_voters ALTER COLUMN gid SET DEFAULT nextval('
    wa_voters_gid_seq'::regclass);
```

And finally delete the records from the imported table where we could not build a geometry. We just delete entries where geometry is empty: delete from wa_voters where the_geom is null; Built internal query index for PostgreSQL using the vacuum command:

```
VACUUM ANALYZE;
```

Now finally the newly loaded data is usable as input for MapServer.

4.3.5 PostGIS Exercises

1. Review the examples in this chapter
2. Create a database with the name *osgis* and a database user *osgis* using pgAdmin
3. spatially enable the new *osgis* data base (create PostGIS extension). Verify if the PostGIS spatial functions are available.
4. Import two shapefiles into PostGIS using shp2pgsql (as described in section 4.3.4 on page 58).
5. Run all the examples listed in Section "Simple Spatial SQL Queries" on page 55 as listed to see the functionalities of PostGIS in action for yourself, or use your own spatial data in similar queries
6. Following the example in section "Loading data from a file into PostGIS and making them spatial" on page 59 load data from a text file into PostGIS and convert them into a spatial data set. You can use the text file /data/layers/-point/locations.csv for this exercise.
7. How could we efficiently store spatial data in multiple projections in PostGIS?
   What would be a simple way to do this?
8. Write a spatial SQL *Select* query that uses a SQL *WHERE* clause with the intersection (true/false) of two features (a point location and a County polygon e.g.) to return the name of the County polygon at the point location. Review this section of the PostGIS documentation for help.

4.3.6 Exercises - PostGIS Layers in MapServer

Additional topics to be covered in the MapServer exercises after completing the chapter on PostGIS:

1. Import a shape file layer of your choice into PostGIS using shp2pgsql (or the shape file loader in pgAdmin)
2. Add the new PostGIS layer to the map file (note use the CONNECTIONTYPE and CONNECTION tags). An example of a PostGIS Layer (*Census Tracts Query*") can also be found in the map file starting on page 100

4.3.7 Using PostGIS with MapServer

Tips from Paul Ramsey http://blog.cleverelephant.ca/2008/10/mapserverpostgis-performance-tips.html
The data statement for a PostGIS layer in a map file can be very simple:

DATA "the_geom from the_table"

Very simple, but: how does MapServer know what primary key to use in queries? And what SRID to use when creating the bounding box selection for drawing maps? The answer is, it asks the database for that information. With two extra queries. Every time it processes the layer. However, if you are explicit about your unique key and SRID in configuration, MapServer can, and does, skip querying the back-end for that information.

DATA "the_geom from the_table using unique gid using srid=4326"

keep database connections open

Another good thing is to specify that the open DB connection should not be closed by default (useful for fast-cgi mode and for multiple PostGIS layers in one map file)

PROCESSING "CLOSE_CONNECTION=DEFER"

4.3.8 Some Notes on PostGIS

To identify which versions of PostGIS and PostgreSQL you are running the following SQL queries can be used:

```
select postgis_lib_version();
-- lists PostGIS version (short) : "1.4.0"

select postgis_full_version();
-- lists PostGIS version including GEOS and PROJ version: "POSTGIS
    ="1.4.0" GEOS="3.1.1-CAPI-1.6.0" PROJ="Rel. 4.6.1, 21 August
    2008" USE_STATS"

select version();
-- lists PostGreSQL version: "POSTGIS="1.4.0" GEOS="3.1.1-CAPI-1.6.0"
     PROJ="Rel. 4.6.1, 21 August 2008" USE_STATS"
```

Information about tuning a PostGIS installation is included in the document **"Postgis-for-power-users.ppt"** included on the DVD.

The following SQL statements illustrate the use of PostGIS spatial functions: ST_DWithin, ST_Line_Locate_Point, and ST_Line_Interpolate_Point. The queries are extracts from PHP scripts and contain some PHP variables; e.g. *$xcoord*.

```
-- st_within  example
-- get closest road in tiger data
SELECT fullname, tlid, Astext(the_geom2) FROM roads WHERE ST_DWithin(
    roads.the_geom2, GeomFromText('POINT($xcoord $ycoord)', 9102003)
    , 50) ORDER BY ST_Distance(roads.the_geom2, GeomFromText('POINT(
    $xcoord $ycoord)', 9102003)) limit 1;

-- find closest point on tiger data road segment
SELECT ST_Line_Locate_Point(ST_LineFromText('LINESTRING(
    $thestreet_wkt_extract_coords)',9102003),GeomFromText('POINT(
    $xcoord $ycoord)', 9102003));

-- calculate point location ratio along tiger data road segment
SELECT astext(ST_Line_Interpolate_Point(ST_LineFromText('LINESTRING(
    $thestreet_wkt_extract_coords)',9102003),
$theratio));
```

The following example illustrates the powerful aggregate functions in PostGIS to create new datasets via union of polygons.

```
-- Query 1: Union all counties of the county polygon data set "
    us_counties" to create the dataset "us_border". This operation
    unions all individual datasets into one polygon encompassing the
     area of the entire US.
```

```
select st_union(the_geom)
into us_border
from us_counties ;

-- Query 2: Union all counties of the county polygon data set "
    us_counties" to create the dataset "us_states". This operation
    unions all individual datasets and groups them by states (that
    is union all County polygon features into one polygon hat belong
     to the same state).
select st_union(the_geom), state_name
into us_states
from us_counties
group by state_name;
```

5 Appendix

5.1 OS Desktop GIS Tools

SpatiaLite is a spatial DBMS built on top of **SQLite** . Both formats are file based and thus are light weight and portable. The spatial components depend on the PROJ and GEOS libraries. Related tools include the **RasterLite** library to handle Raster data and **spatialite-gis** (a minimalistic GIS tool). SpatiaLite has the potential to replace shapefiles as a simple data exchange format. Starting with version 1.1 QGIS can read the format, support by OGR/GDAL was included since version 1.7.0.

file based
DBMS
light weight
portable

Quantumnik is a plug-in for QGIS that enables the use of Mapnik as an alternative rendering engine in QGIS. This is useful because Mapnik is said to render the nicest looking maps of all web mapping engines. It also supports on-the-fly translation of QGIS layers and styles into Mapnik objects, enables the export of QGIS projects into Mapnik XML map files, and the loading of Mapnik XML for dynamic rendering in QGIS. The plug-in also requires a working installation of Mapnik. Download here.

Mapnik as an alternative rendering engine in QGIS

5.2 Basic Libraries - Using PROj, OGR, and GDAL

OGR and GDAL are used in many Desktop GIS systems:
- **ArcGIS**
- **GRASS**
- **Quantum GIS**

GDAL - the Geospatial Data Abstraction Library (raster) and OGR - the OpenGIS Simple Features Reference Implementation (vector) are a set of tools for reading, writing and processing of raster and vector data sets in many different formats (tables are in the resource section). They are the base for many Desktop GIS systems, e.g. **ArcGIS**. OGR greatly extends the input formats MapServer can read: Oracle Spatial, ESRI Geodatabase (MDB), TIGER, and MapInfo. PROJ4 is a library for cartographic projection routines. It includes a stand alone projection utility *proj* and includes support for more than 2500 projections (epsg and esri lists).

About Proj4

Proj4 utilities program proj.exe and library proj.dll projection definition files

The Proj4 project is hosted at http://trac.osgeo.org/proj. The processing of data involving projection routines in OGR and GDAL are based on the Proj library. The Proj4 utilities include:

- Program proj.exe and library proj.dll
- Projection definition files epsg[1] and esri (in proj_lib dir)

Using OGR

collection of utility programs
- **ogrinfo**
- **ogr2ogr**
- **ogrtindex**

OGR includes a collection of utility programs that can be used on the command line to process vector data.

- **ogrinfo** http://www.gdal.org/ogr/ogrinfo.html
  The ogrinfo utility lists various information about an OGR supported data source.
- **ogr2ogr** http://www.gdal.org/ogr/ogr2ogr.html
  This program can be used to convert simple features data between file formats performing various operations during the process such as spatial or attribute selections, reducing the set of attributes, setting the output coordinate system or even reprojecting the features during translation.

[1] EPSG - The European Petroleum Survey Group http://www.epsg.org

- **ogrtindex** http://www.gdal.org/ogr/ogrtindex.html The ogrtindex program can be used to create a tile index - a file containing a list of the identities of a bunch of other files along with their spatial extents. This is primarily intended to be used with the UMN MapServer for tiled access to layers using the OGR connection type.

Where is my ArcCatalog? To get meta information about a vector file you can use **ogrinfo**. For example on the command line we can find out what type of data is stored in counties2008.shp:

where is my ArcCatalog? get information about a shapefile

```
ogrinfo counties2008.shp

This gives us:\\
INFO: Open of `counties2008.shp'
      using driver `ESRI Shapefile' successful.
1: counties2008 (Polygon)
```

What do the following commands give us ?

ogrinfo <filename>

```
ogrinfo counties2008.shp counties2008 -so
```

or connecting to PostGIS layer *counties*:

```
ogrinfo PG:"host=127.0.0.1 user=postgres password=
    postgres dbname=osgis port=5432" counties -summary
```

Determine which spatial types (point, line polygon..) the following data sets are:

- data1.shp
- sunarea.tab
- whatisit.kml
- data4.shp

- **ogr2ogr** Type in **ogr2ogr** at the command line. This will list the options available with the utility. This gives us

```
Usage: ogr2ogr [--help-general] [-skipfailures] [-append]
    [-update] [-gt n]
               [-select field_list] [-where
                   restricted_where]
               [-sql <sql statement>]
               [-spat xmin ymin xmax ymax] [-preserve_fid
                   ] [-fid FID]
               [-a_srs srs_def] [-t_srs srs_def] [-s_srs
                   srs_def]
               [-f format_name] [-overwrite] [[-dsco NAME
                   =VALUE] ...]
               [-segmentize max_dist]
               dst_datasource_name src_datasource_name
               [-lco NAME=VALUE] [-nln name] [-nlt type]
                   [layer [layer ...]]

 -f format_name: output file format name, possible values
     are:, "ESRI Shapefile", "MapInfo File", "TIGER",
    "S57", "DGN", "Memory", "BNA", "CSV", "GML", "GPX",
     "KML", "GeoJSON", "Interlis 1", "Interlis 2", "GMT
    ", "SQLite", "ODBC", "PostgreSQL", "MySQL", "
    Geoconcept"...
```

- Use ogr2ogr to reproject one of the files listed above to a different projection of your choice.
  Note: use *-t_srs* to specify the target projection.
- Produce a shapefile containing all uninhabited areas that are bigger than 500000000 (square feet) using ogr2ogr: Use a select statement with ogr2ogr. Base data is *uninhabited.shp*, the attribute containing the square feet values is "AREA".
- How can we at the same time convert the output result to a different format - like Geographic Markup Language (GML) or Census Tiger files (TIGER)?

- Create a batch file to convert 3 shapefiles to MapInfo files at once.

Using ogrtindex we can create tile indexes: A shapefile that contains the shapes of data that is split into small tiles which is good practice for larger datasets for use with MapServer.

Using GDAL

gdalinfo <filename> gdal_translate

Using gdalinfo we can get meta information about raster files.

- Use **gdalinfo** to retrieve information about "wa_shade_1km.tif". What information does this give us?
- Convert the tiff raster wa_shade_1km.tif into an ECW image using gdal_translate.
- Reproject wa_shade_1km.tif using gdal_translate into geographic projection(epsg:4326). Verify that the output projection is indeed geographic.

5.3 OS Desktop GIS Programs

OS software for almost any geospatial task

There is software that supports almost any task one can think of related to the processing, the analysis and the publishing of geospatial data. The following lists software for a variety of common applications in GIS, Remote Sensing and data analysis.

5.3.1 Geographic Resources Analysis Support System (GRASS)

GRASS - Powerful desktop GIS and image analysis for Remote Sensing

GRASS is comparable with Arc/Info

GRASS was originally started in 1982 by the US Army to implement functionality not available in other GIS systems at the time. After it was discontinued in 1995, its revival started in 1997 by Baylor University. Since 2001 the main development is housed at ITC. In 2008 the first standalone windows version was released in April with version 6.2.3. The system was originally started as a Raster GIS and Remote Sensing image analysis software but over the years extensive vector support was added. The capabilities are comparable with Arc/Info and in addition covers image analysis.

Table 14: OS Geospatial Desktop Programs

Name	Type
Geographic Resources Analysis Support System (GRASS)	Desktop GIS
User friendly Desktop Internet GIS (uDig) and JGrass	
Quantum GIS (QGIS) and Open Ocean Map	
OpenJUMP	
gvSIG	
MapWindow	
The Generic Mapping Tools (GMT)	Raster map automation
Spatial Data Integrator	Extract Translate Load (ETL)
Open Source software Image Map (OSSIM)	Remote Sensing
The R Project for Statistical Computing (R)	Statistical software, scripting language

Table 15: GRASS Project

Main supporter of **GRASS**	GRASS Development Team, ITC, Trento, Italy (since 2001)
Functionality	Comprehensive Desktop GIS and Image analysis
Operating systems	Unix/Linux, Windows (2008)
Project started	1982, open source since 1999
Implementation	C
OS libraries	OGR/GDAL
PostGIS support	Yes
License	GPL

The Masters Thesis by Buchanan compares the functionality of Arc/Info 9.0 and GRASS 6.0 (see in references). One conclusion is that GRASS has some weaknesses in the ease of use of the user interface. However, this can be mediated by using QGIS (with the GRASS plug-in) or JGrass/uDig to remote control its functionality.

5.3.2 User friendly Desktop Internet GIS (uDig) and JGrass

uDig

JGrass

One of the goals of uDig, the "User-friendly Desktop Internet GIS" is to bring Internet resources to the desktop GIS user. It is a desktop GIS with editing capabilities based on the GeoTools library and has strong capabilities to connect to Internet resources such as WMS/WFS and other network resources. Thus it combines the strength of a Desktop viewer, editor and general GIS with access to web based services, databases and other resources. JGrass is a uDig based GIS for hydrological and geomorphological analysis. uDig is the UI for JGrass. The functions in JGrass are either GRASS functions rewritten in Java or wrapped GRASS analysis functions. To install it, use a package that includes uDig from the JGrass website.

Table 16: uDig Project

Main supporter of **uDig**	Refractions Research, Victoria, Canada
Type	Multilingual Desktop GIS
Functionality	Strong WMS/WFS support, Styled Layer Descriptor (SLD) support, vector editing, advanced map theming using ColorBrewer
Operating systems	Multi platform, Unix/Linux, Windows (2008)
Implementation	Java, using Eclipse for development
OS libraries	GeoTools
PostGIS support	Yes
License	LGPL

5.3.3 Quantum GIS (QGIS)

QGIS

QGIS was originally developed as a GIS viewing environment for the Linux desktop but is available for Solaris, Windows and Mac operating systems. Data sources for Quantum GIS can be PostGIS and shapefiles as vector data sources. Internally, QGIS uses the OGR library and therefore supports all OGR raster formats e.g. DEM, ArcGrid, ERDAS, SDTS, and GeoTIFF.

Table 17: Quantum GIS (QGIS) Project

Main supporter of **Quantum GIS**	Gary Sherman and others
Type	Desktop GIS Viewer
Functionality	Can be used as a UI to GRASS GIS with GRASS Plug-in, Python bindings allow for programmatic interaction
Operating systems	Multi platform
Project started	2002
Implementation	C++, Depends on QT widget
OS libraries	OGR/GDAL
PostGIS support	Yes
License	GPL

5.3.4 OpenJUMP - JUMP (JAVA Unified Mapping Platform)

OpenJUMP

JUMP is the "JUMP Unified Mapping Platform". It did experience some ups and downs during its development and as a result is available in a variety of "flavors" such as JUMP, OpenJUMP, and Kosmo. It was designed as an environment extensible platform into which spatial data conflation could be embedded (which was a major initial goal for its support by the British Columbia Ministry of Sustainable Resource Management). It provides functionality for viewing, and processing of spatial data. GML or "Geography Markup Language" is used for its main data format, but also can read and write shapefile, dxf and PostGIS vector data formats. Notably OpenJUMP is a great tool for editing, QA and correction of spatial data with problem solving capabilities.

Table 18: OpenJUMP Project

Main supporter of **OpenJUMP**	Vivid Solutions and Kosmo-SAIG
Type	Desktop GIS in a Variety of "Flavors" (JUMP / OpenJUMP / Kosmo)
Functionality	Desktop GIS - Viewer - Analysis, powerful editing and QA environment, e.g. shapefile problem resolving capabilities
Operating systems	Multi platform
Project started	2002
Implementation	Java
OS libraries	JTS Topology Suite
PostGIS support	Yes
License	LGPL

5.3.5 gvSIG - Generalitat Valencia Sistema de Información Geográfica

gvSIG

improved labeling support with the new PAL library - better suited for cartography

gvSIG is a project of the Spanish province of Valencia. The goals of the project are to provide an open source GIS that is platform independent and based on open source standards. Basically the capabilities should be comprehensive enough to replace ESRI's ArcView 3 desktop GIS. The user interface and functionalities of gvSIG are similar to ArcView 3, but in addition has capabilities to connect to Internet mapping services. The integration of a new labeling library "PAL" enables better labeling and brings gvSIG closer to having the same labeling support that is available in proprietary software such as ArcGIS. Another Java based project of the autonomous region of Extremadura called **Sextante** can be installed as a plug-in and offers more than 300 spatial analysis functions.

Table 19: gvSIG Project

Main supporter of **gvSIG**	Generalitat Valencia (GVA) - Province of Valencia, Spain
Type	Desktop GIS
Functionality	Multilingual Desktop GIS - Viewer - Analysis, analysis functions can be greatly extended when installing Sextante
Operating systems	Unix/Linux, Windows
Project started	2003
Implementation	Java
OS libraries	GeoTools and JTS
PostGIS support	Yes
License	GPL

5.4 General Resources

5.4.1 Popular FOSS4G Licenses

GNU-GPL

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BSD

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Mozilla

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5.4.2 Books

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Obe, R.& Hsu, L.(2011): PostGIS in Action. Manning.520 pages, ISBN: 9781935182269.`http://www.manning.com/obe/`

OSGEO (eds.)(2008): Libro SIG: Sistemas de Informacion Geografica (Free GIS book in spanish) , 800+ pages.`http://wiki.osgeo.org/wiki/Libro_SIG`

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Santiago, A. (expected end of 2014): The book of OpenLayers 3. Theory & Practice. Leanpub ebook.(work in progress).

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5.4.3 Articles

The State of Open Source GIS, Version 2006. By Paul Ramsey, formerly Refractions Research, Victoria. 49 pages.

Comparison Of Geographic Information System Software (ArcGIS 9.0 And GRASS 6.0): Implementation And Case Study MS Thesis by Todd R. Buchanan, Fort Hays State University. 100 pages.

Geospatial Interoperability Return on Investment Study (2005). National Aeronautics and Space Administration, Geospatial Interoperability Office. 80 pages.

Current state of technology and potential of Smart Map Browsing (2007) in web browsers using the example of the Free web mapping application OpenLayers by Emanuel Schütze. 128 pages.

An Overview on Current Free and Open Source Desktop GIS Developments (2008) by Steiniger, S. & Bocher, E. Accepted for publication in Int. J. of Geographical Information Science, 1. Revision, Sept. 5th 2008. 24 pages. (included on class DVD)

5.4.4 General Web Sites

Table 20: FOSS4G web sites

Name	URL
Free GIS Project	http://www.freegis.org
Open source GIS list	http://opensourcegis.org
Map Tools	http://maptools.org
OSGeo	http://www.osgeo.org

5.4.5 Open source utilities

Table 21: Open source utilities

Name	URL
Simple Feature Library (OGR)	www.gdal.org/ogr
Geospatial Data Abstraction Library (GDAL)	www.gdal.org
GeoTools	http://geotools.org/
PROJ4 (Cartographic Projections Library)	http://trac.osgeo.org/proj
FWTools (utility collection)	http://fwtools.maptools.org
MapTiler (GUI to tile Rasters)	http://www.maptiler.org/
GMT	http://gmt.soest.hawaii.edu
TerraLib	http://www.terralib.org
Spatial Data Integrator (ETL tool)	www.spatialdataintegrator.com
Geokettle (ETL tool)	www.geokettle.org
Open Source Software Image Map (OSSIM)	http://www.ossim.org
The R Project for Statistical Computing	http://www.r-project.org

5.4.6 Web Mapping Software

Table 22: Web Mapping Software

Name	URL
MapServer	http://mapserver.org
MapServer and Node.js	https://github.com/pagameba/node-mapserver
GeoServer	http://geoserver.org
Mapnik	http://www.mapnik.org
Mapnik and Node.js	https://github.com/mapnik/node-mapnik
Deegree	http://www.deegree.org
MapGuide	http://mapguide.osgeo.org
OpenLayers	www.openlayers.org
Polymaps (JS, SVG)	http://polymaps.org/
Leaflet (lightweight JS Library)	http://leaflet.cloudmade.com
Modestmaps (lightweight JS Library)	http://modestmaps.com
Mapstraction (lightweight JS Library)	http://mapstraction.com
Mapbender	www.mapbender.org
MapFish	http://www.mapfish.org
GeoDjango (now merged into Django)	https://www.djangoproject.com/ formerly
MapQuery (for use with jQuery)	http://mapquery.org
D3 (Data-Driven Documents)	http://d3js.org/

5.4.7 Additonal tools for use with OpenLayers

Table 23: OpenLayers additional tools

Name	URL
i2maps (geocomputing environment to use with OpenLayers)	http://ncg.nuim.ie/i2maps
Acidmaps (interpolated map images with Geoserver/OpenLayers)	http://acidmaps.org
OpenLayers Editor (from Geops)	https://github.com/geops/ole

5.4.8 Map Tiling engines

Table 24: Map Tiling engines

Name	URL
TileCache	www.tilecache.org
GeoWebCache	http://geowebcache.org
MapProxy (tiles, server proxy, security)	http://mapproxy.org
MapCache	http://www.mapserver.org/mapcache/
Tilemill (map styling)	http://mapbox.com/tilemill

5.4.9 Databases and Additional Software

Table 25: Databases and Additional Software

Name	URL
PostgreSQL	www.postgresql.org
PostGIS	http://postgis.refractions.net
SpatiaLite	http://www.gaia-gis.it/spatialite
Geocouch (document based db)	https://github.com/couchbase/geocouch
Proj4js	http://proj4js.org
FeatureServer	http://featureserver.org/
WAS,WSS, and WSC (52N Security Community)	http://52north.org
GeoPrisma (security)	http://geoprisma.org
GeoShield (security)	http://sites.google.com/site/geoshieldproject
GeoExt	http://www.geoext.org
Ext JS	http://www.sencha.com

5.4.10 Desktop GIS List

Table 26: Desktop GIS

Name	URL
MapWindow	www.mapwindow.org
OpenJump	http://openjump.org
GRASS	http://grass.osgeo.org
QGIS	http://www.qgis.org
Quantumnik	https://github.com/springmeyer/quantumnik/
gvSIG	http://www.gvsig.org
gvSIG CE	http://gvsigce.org/
uDig	http://udig.refractions.net
JGrass	http://code.google.com/p/jgrass
TerraLib	http://www.terralib.org

5.4.11 GIS Samplers, Live DVDs, and Compilations

Table 27: GIS Samplers, Live DVDs, and Compilations

Name	URL
OSGEO Live DVD image	http://live.osgeo.org
GIS Virtual Machine	http://www.gisvm.com
MapServer for Windows	http://maptools.org/ms4w/index.phtml
OSGEO for Windows	http://trac.osgeo.org/osgeo4w
Ubuntu GIS	https://wiki.ubuntu.com/UbuntuGIS
OpenGeo Community Suite (PostGIS, GeoServer, GeoWebCache, OpenLayers, GeoExt)	http://boundlessgeo.com/solutions/opengeo-suite/download/

5.4.12 Conferences

Table 28: Free and Open Source Software for Geospatial (FOSS4G)

Year	Name	Dates	URL
2014	Portland, USA	September 8-13, 2014	`http://2014.foss4g.org`
2013	Nottingham, UK	September 17-21, 2013	`http://2013.foss4g.org`
2011	Denver, USA	September 12-16, 2011	`http://2011.foss4g.org`
2010	Barcelona, Spain	September 6-9, 2010	`http://2010.foss4g.org`
2009	Sydney, Australia	October 20-23, 2009	`http://2009.foss4g.org`
2008	Cape Town, South Africa	Sep/Oct 2008	`www.foss4g2008.org`
2007	Victoria, Canada	September 2007	`http://www.foss4g2007.org`
2006	Lausanne, Switzerland	September 2006	`http://www.foss4g2006.org`

5.4.13 User Groups

Cascadia Users of Geospatial Open Source: Seattle based GIS user group. Monthly meeting every 3rd Wednesday, 6:00 pm. Mostly in the LizardTech offices, located near Pioneer Square. `http://www.cugos.org`

5.4.14 Mailing Lists

Table 29: Mailing Lists

List	email or URL
List archives	`http://osgeo-org.1803224.n2.nabble.com`
Mapbender	mapbender_users@lists.osgeo.org
PostGIS	postgis-users@postgis.refractions.net
PostgreSQL	pgsql-general@postgresql.org
MapServer	mapserver-users@lists.osgeo.org
GeoServer	geoserver-users@lists.sourceforge.net
OpenLayers	users@OpenLayers.org
TileCache	tilecache@OpenLayers.org
MapFish	users@mapfish.org

5.4.15 Internet Relay Chat (IRC)

URL: irc://freenode.net Channels for Mapbender, PostGIS, PostgreSQL, MapServer, GeoServer, OpenLayers, and MapFish. One client to use for IRC is Chatzilla. Chatzilla is an add-on to Mozilla Firefox. More information here

5.4.16 Meeting the Pros

Table 30: Meeting the Pros

Name	Focus	blog/website/info
Planet OSGeo (Blog Aggregator)	All mixed	`http://planet.osgeo.org`
Paul Ramsey	PostGIS, MapServer	`http://blog.cleverelephant.ca`
Steve Lime	MapServer	`http://www.osgeo.org/spotlight/stevelime`
Christopher Schmidt	OpenLayers, FeatureServer	`http://crschmidt.net/blog`

5.4.17 Installing a Web GIS Server from the Ubuntu GIS Repository

Note that this is not a comprehensive guide but in short one needs to add the Ubuntu repositories to the server apt list, which on a typical system is located at /etc/apt/sources.list . It is a good idea to determine exactly which operating system version the server is running (if you not already aware of it) for example see below you are running Ubuntu *Hardy Heron*.

```
lsb_release -c
> hardy
% this means you are running the hardy version of Ubuntu
```

The following lines need to be added to the sources.list using a text editor:

```
deb http://ppa.launchpad.net/ubuntugis/ppa/ubuntu hardy main
deb-src http://ppa.launchpad.net/ubuntugis/ppa/ubuntu hardy main
```

The next step is to authenticate the repository (314DF160 is the OpenPGP key of the Ubuntu GIS repository):

```
sudo apt-key adv --keyserver keyserver.ubuntu.com --recv-keys 314
    DF160
```

Starting with Ubuntu 9.10 (Karmic Koala) the Launchpad PPA (Personal Package Archive) repositories can also be added via command line (without manually editing the sources.list file and no need to authenticate the repository):

```
sudo apt-get install python-software-properties
sudo add-apt-repository ppa:ubuntugis/ppa
```

After updating your apt utility software package list you will be ready to start the GIS installation

```
sudo apt-get update
```

The following is an example for an installation sequence to set-up a Web Mapping enabled GIS Server. You see that all available packages can be installed (and also later be removed if needed) not only GIS components.

```
# install apache version 2
sudo apt-get install apache2

# install php
# see \url{https://help.ubuntu.com/8.04/serverguide/C/php5.html}
sudo apt-get install php5 libapache2-mod-php5
sudo apt-get install php5-cli
sudo apt-get install php5-cgi
sudo apt-get install php5-mysql # for MySql
sudo apt-get install php5-pgsql # for PostgreSQL

# install gdal
 sudo apt-get install gdal-bin
```

```
# install proj
 sudo apt-get install proj

# install PostgreSQL and PostGIS
sudo apt-get install postgresql-8.4.4
apt-get install postgresql-server-dev-8.4 libpq-dev
apt-get install libgeos-dev
sudo apt-get install postgis-1.5
```

At this point you may take care of initial PostgreSQL housekeeping tasks (but yo can also save that for later)

```
# To set a password for the postgres database user this on the
    command line
psql -c"ALTER user postgres WITH PASSWORD 'postgres'"

# Switch to postgres user
sudo su - postgres

# Create the plgsql language inside the database template:
createlang -d template_postgis plpgsql
```

Continue with the installation of Mapserver and Tilecache:

```
# install mapserver
sudo apt-get install cgi-mapserver
sudo apt-get install mapserver-bin

# install python image library
sudo apt-get install libjpeg62 libjpeg62-dev zlib1g-dev

# install tilecache
sudo apt-get install tilecache
```

5.4.18 GDAL and OGR Formats

Table 31: GDAL Raster Formats

Long Format Name	Code	Creation	Georef.	Max.size	Compiled by default
Arc/Info ASCII Grid	AAIGrid	Yes	Yes	2GB	Yes
ACE2	ACE2	No	Yes	–	Yes
ADRG/ARC Digitilized Raster Graphics (.gen/.thf)	ADRG	Yes	Yes	–	Yes
Arc/Info Binary Grid (.adf)	AIG	No	Yes	–	Yes
AIRSAR Polarimetric	AIRSAR	No	No	–	Yes
Magellan BLX Topo (.blx, .xlb)	BLX	Yes	Yes	–	Yes
Bathymetry Attributed Grid (.bag)	BAG	No	Yes	2GiB	No, needs libhdf5
Microsoft Windows Device Independent Bitmap (.bmp)	BMP	Yes	Yes	4GiB	Yes
BSB Nautical Chart Format (.kap)	BSB	No	Yes	–	Yes, can be disabled
VTP Binary Terrain Format (.bt)	BT	Yes	Yes	–	Yes
CEOS (Spot for instance)	CEOS	No	No	–	Yes
DRDC COASP SAR Processor Raster	COASP	No	No	–	Yes
TerraSAR-X Complex SAR Data Product	COSAR	No	No	–	Yes
Convair PolGASP data	CPG	No	Yes	–	Yes
USGS LULC Composite Theme Grid	CTG	No	Yes	–	Yes
Spot DIMAP (metadata.dim)	DIMAP	No	Yes	–	Yes
ELAS DIPEx	DIPEx	No	Yes	–	Yes
DODS / OPeNDAP	DODS	No	Yes	–	No, needs libdap
First Generation USGS DOQ (.doq)	DOQ1	No	Yes	–	Yes
New Labelled USGS DOQ (.doq)	DOQ2	No	Yes	–	Yes

GDAL Raster Formats continued from previous page

Long Format Name	**Code**	**Creation**	**Georef.**	**Max.size**	**Compiled by default**
Military Elevation Data (.dt0, .dt1, .dt2)	DTED	Yes	Yes	–	Yes
Arc/Info Export E00 GRID	E00GRID	No	Yes	–	Yes
ECRG Table Of Contents (TOC.xml)	ECRGTOC	No	Yes	–	Yes
ERDAS Compressed Wavelets (.ecw)	ECW	Yes	Yes		No, needs ECW SDK
ESRI .hdr Labelled	EHdr	Yes	Yes	No limits	Yes
Erdas Imagine Raw	EIR	No	Yes	–	Yes
NASA ELAS	ELAS	Yes	Yes	–	Yes
ENVI .hdr Labelled Raster	ENVI	Yes	Yes	No limits	Yes
Epsilon - Wavelet compressed images	EPSILON	Yes	No	–	No, needs EPSILON library
ERMapper (.ers)	ERS	Yes	Yes		Yes
Envisat Image Product (.n1)	ESAT	No	No	–	Yes
EOSAT FAST Format	FAST	No	Yes	–	Yes
FIT	FIT	Yes	No	–	Yes
FITS (.fits)	FITS	Yes	No	–	No, needs libcfitsio
Fuji BAS Scanner Image	FujiBAS	No	No	–	Yes
Generic Binary (.hdr Labelled)	GENBIN	No	No	–	Yes
Oracle Spatial GeoRaster	GEORASTER	Yes	Yes	–	No, needs Oracle client libraries
GSat File Format	GFF	No	No	–	Yes
Graphics Interchange Format (.gif)	GIF	Yes	No	2GB	Yes (internal GIF library provided)
WMO GRIB1/GRIB2 (.grb)	GRIB	No	Yes	2GB	Yes, can be disabled
GMT Compatible netCDF	GMT	Yes	Yes	2GB	No, needs libnetcdf
GRASS Rasters	GRASS	No	Yes	–	No, needs libgrass
GRASS ASCII Grid	GRASS ASCII Grid	No	Yes	–	Yes

GDAL Raster Formats continued from previous page

Long Format Name	Code	Creation	Georef.	Max.size	Compiled by default
Golden Software ASCII Grid	GSAG	Yes	No	–	Yes
Golden Software Binary Grid	GSBG	Yes	No	4GB	Yes
Golden Software Surfer 7 Binary Grid	GS7BG	No	No	4GiB	Yes
GSC Geogrid	GSC	Yes	No	–	Yes
TIFF / BigTIFF / GeoTIFF (.tif)	GTiff	Yes	Yes	4GiB for classical TIFF / No limits for BigTIFF	Yes (internal libtiff and libgeotiff provided)
NOAA .gtx vertical datum shift	GTX	Yes	Yes		Yes
GXF - Grid eXchange File	GXF	No	Yes	4GiB	Yes
Hierarchical Data Format Release 4 (HDF4)	HDF4	Yes	Yes	2GiB	No, needs libdf
Hierarchical Data Format Release 5 (HDF5)	HDF5	No	Yes	2GiB	No, needs libhdf5
HF2/HFZ heightfield raster	HF2	Yes	Yes	-	Yes
Erdas Imagine (.img)	HFA	Yes	Yes	No limits2	Yes
Image Display and Analysis (WinDisp)	IDA	Yes	Yes	2GB	Yes
ILWIS Raster Map (.mpr,.mpl)	ILWIS	Yes	Yes	–	Yes
Intergraph Raster	INGR	Yes	Yes	2GiB	Yes
USGS Astrogeology ISIS cube (Version 2)	ISIS2	Yes	Yes	–	Yes
USGS Astrogeology ISIS cube (Version 3)	ISIS3	No	Yes	–	Yes
JAXA PALSAR Product Reader (Level 1.1/1.5)	JAXAPALSAR	No	No	–	Yes
Japanese DEM (.mem)	JDEM	No	Yes	–	Yes
JPEG JFIF (.jpg)	JPEG	Yes	Yes	4GB	Yes (internal libjpeg provided)
JPEG-LS	JPEGLS	Yes	No	–	No, needs CharLS library

GDAL Raster Formats continued from previous page

Long Format Name	Code	Creation	Georef.	Max.size	Compiled by default
JPEG2000 (.jp2, .j2k)	JPEG2000	Yes	Yes	2GiB	No, needs libjasper
JPEG2000 (.jp2, .j2k)	JP2ECW	Yes	Yes	500MB	No, needs ECW SDK
JPEG2000 (.jp2, .j2k)	JP2KAK	Yes	Yes	No limits	No, needs Kakadu library
JPEG2000 (.jp2, .j2k)	JP2MrSID	Yes	Yes		No, needs MrSID SDK
JPEG2000 (.jp2, .j2k)	JP2OpenJPEG	Yes	Yes		No, needs OpenJPEG library (v2)
JPIP (based on Kakadu)	JPIPKAK	No	Yes		No, needs Kakadu library
KMLSUPEROVERLAY	KML SUPER OVERLAY	Yes	Yes		Yes
NOAA Polar Orbiter Level 1b Data Set (AVHRR)	L1B	No	Yes	–	Yes
Erdas 7.x .LAN and .GIS	LAN	No	Yes	2GB	Yes
FARSITE v.4 LCP Format	LCP	No	Yes	No limits	Yes
Daylon Leveller Heightfield	Leveller	No	Yes	2GB	Yes
NADCON .los/.las Datum Grid Shift	LOSLAS	No	Yes		Yes
In Memory Raster	MEM	Yes	Yes		Yes
Vexcel MFF	MFF	Yes	Yes	No limits	Yes
Vexcel MFF2	MFF2 (HKV)	Yes	Yes	No limits	Yes
MG4 Encoded Lidar	MG4Lidar	No	Yes	–	No, needs LIDAR SDK
Multi-resolution Seamless Image Database	MrSID	No	Yes	–	No, needs MrSID SDK
Meteosat Second Generation	MSG	No	Yes		No, needs msg library
EUMETSAT Archive native (.nat)	MSGN	No	Yes		Yes
NLAPS Data Format	NDF	No	Yes	No limits	Yes

GDAL Raster Formats continued from previous page

Long Format Name	Code	Creation	Georef.	Max.size	Compiled by default
NITF (.ntf, .nsf, .gn?, .hr?, .ja?, .jg?, .jn?, .lf?, .on?, .tl?, .tp?, etc.)	NITF	Yes	Yes	10GB	Yes
NetCDF	netCDF	Yes	Yes	2GB	No, needs libnetcdf
NTv2 Datum Grid Shift	NTv2	Yes	Yes		Yes
Northwood/ VerticalMapper Classified Grid Format .grc/.tab	NWT_GRC	No	Yes	–	Yes
Northwood/ VerticalMapper Numeric Grid Format .grd/.tab	NWT_GRD	No	Yes	–	Yes
OGDI Bridge	OGDI	No	Yes	–	No, needs OGDI library
OZI OZF2/OZFX3	OZI	No	Yes	–	No
PCI .aux Labelled	PAux	Yes	No	No limits	Yes
PCI Geomatics Database File	PCIDSK	Yes	Yes	No limits	Yes
PCRaster	PCRaster	Yes	Yes		Yes (internal libcsf provided)
Geospatial PDF	PDF	No	Yes	–	No, needs libpoppler or libpodofo
NASA Planetary Data System	PDS	No	Yes	–	Yes
Portable Network Graphics (.png)	PNG	Yes	No		Yes (internal libpng provided)
PostGIS Raster (previously WKTRaster)	PostGIS Raster	No	Yes	–	No, needs PostgreSQL library
Netpbm (.ppm,.pgm)	PNM	Yes	No	No limits	Yes
R Object Data Store	R	Yes	No	–	Yes
Rasdaman	RASDAMAN	No	No	No limits	No (needs raslib)
Rasterlite - Rasters in SQLite DB	Rasterlite	Yes	Yes	–	No (needs OGR SQLite driver)

GDAL Raster Formats continued from previous page

Long Format Name	**Code**	**Creation**	**Georef.**	**Max.size**	**Compiled by default**
Swedish Grid RIK (.rik)	RIK	No	Yes	4GB	Yes (internal zlib is used if necessary)
Raster Matrix Format (*.rsw, .mtw)	RMF	Yes	Yes	4GB	Yes
Raster Product Format/RPF (CADRG, CIB)	RPFTOC	No	Yes	–	Yes
RadarSat2 XML (product.xml)	RS2	No	Yes	4GB	Yes
Idrisi Raster	RST	Yes	Yes	No limits	Yes
SAGA GIS Binary format	SAGA	Yes	Yes	–	Yes
SAR CEOS	SAR_CEOS	No	Yes	–	Yes
ArcSDE Raster	SDE	No	Yes	–	No, needs ESRI SDE
USGS SDTS DEM (*CATD.DDF)	SDTS	No	Yes	–	Yes
SGI Image Format	SGI	Yes	Yes	–	Yes
Snow Data Assimilation System	SNODAS	No	Yes	–	Yes
Standard Raster Product (ASRP/USRP)	SRP	No	Yes	2GB	Yes
SRTM HGT Format	SRTMHGT	Yes	Yes	–	Yes
Terragen Heightfield (.ter)	TERRAGEN	Yes	No	–	Yes
EarthWatch/DigitalGlobe .TIL	TIL	No	No	–	Yes
TerraSAR-X Product	TSX	Yes	No	–	Yes
USGS ASCII DEM / CDED (.dem)	USGSDEM	Yes	Yes	–	Yes
GDAL Virtual (.vrt)	VRT	Yes	Yes	–	Yes
OGC Web Coverage Service	WCS	No	Yes	–	No, needs libcurl
WEBP	WEBP	Yes	No	–	No, needs libwebp
OGC Web Map Service	WMS	No	Yes	–	No, needs libcurl
X11 Pixmap (.xpm)	XPM	Yes	No		Yes
ASCII Gridded XYZ	XYZ	Yes	Yes	–	Yes
ZMap Plus Grid	ZMap	Yes	Yes		Yes

Table 32: OGR Vector Formats

Format Name	Code	Creation	Georef.	Compiled by default
Aeronav FAA files	AeronavFAA	No	Yes	Yes
ESRI ArcObjects	ArcObjects	No	Yes	No, needs ESRI ArcObjects
Arc/Info Binary Coverage	AVCBin	No	Yes	Yes
Arc/Info .E00 (ASCII) Coverage	AVCE00	No	Yes	Yes
Atlas BNA	BNA	Yes	No	Yes
AutoCAD DXF	DXF	Yes	No	Yes
Comma Separated Value (.csv)	CSV	Yes	No	Yes
CouchDB / GeoCouch	CouchDB	Yes	Yes	No, needs libcurl
DODS/OPeNDAP	DODS	No	Yes	No, needs libdap
EDIGEO	EDIGEO	No	Yes	Yes
ESRI FileGDB	FileGDB	Yes	Yes	No, needs FileGDB API library
ESRI Personal GeoDatabase	PGeo	No	Yes	No, needs ODBC library
ESRI ArcSDE	SDE	No	Yes	No, needs ESRI SDE
ESRI Shapefile	ESRI Shapefile	Yes	Yes	Yes
FMEObjects Gateway	FMEObjects Gateway	No	Yes	No, needs FME
GeoJSON	GeoJSON	Yes	Yes	Yes
Géoconcept Export	Geoconcept	Yes	Yes	Yes
Geomedia .mdb	Geomedia	No	No	No, needs ODBC library
GeoRSS	GeoRSS	Yes	Yes	Yes (read support needs libexpat)
Google Fusion Tables	GFT	Yes	Yes	No, needs libcurl
GML	GML	Yes	Yes	Yes (read support needs Xerces or libexpat)
GMT	GMT	Yes	Yes	Yes
GPSBabel	GPSBabel	Yes	Yes	Yes (needs GPSBabel and GPX driver)
GPX	GPX	Yes	Yes	Yes (read support needs libexpat)
GRASS	GRASS	No	Yes	No, needs libgrass
GPSTrackMaker (.gtm, .gtz)	GPS Track Maker	Yes	Yes	Yes
Hydrographic Transfer Format	HTF	No	Yes	Yes

OGR Vector Formats continued from previous page

Long Format Name	Code	Creation	Georef.	Compiled by default
Idrisi Vector (.VCT)	Idrisi	No	Yes	Yes
Informix DataBlade	IDB	Yes	Yes	No, needs Informix DataBlade
INTERLIS	"Interlis 1" and "Interlis 2"	Yes	Yes	No, needs Xerces (INTERLIS model reading needs ili2c.jar)
INGRES	INGRES	Yes	No	No, needs INGRESS
KML	KML	Yes	Yes	Yes (read support needs libexpat)
LIBKML	LIBKML	Yes	Yes	No, needs libkml
Mapinfo File	MapInfo File	Yes	Yes	Yes
Microstation DGN	DGN	Yes	No	Yes
Access MDB (PGeo and Geomedia capable)	MDB	No	Yes	No, needs JDK/JRE
Memory	Memory	Yes	Yes	Yes
MySQL	MySQL	No	Yes	No, needs MySQL library
NAS - ALKIS	NAS	No	Yes	No, needs Xerces
Oracle Spatial	OCI	Yes	Yes	No, needs OCI library
ODBC	ODBC	No	Yes	No, needs ODBC library
MS SQL Spatial	MSSQLSpatial	Yes	Yes	No, needs ODBC library
OGDI Vectors (VPF, VMAP, DCW)	OGDI	No	Yes	No, needs OGDI library
OpenAir	OpenAir	No	Yes	Yes
PCI Geomatics Database File	PCIDSK	No	No	Yes, using internal PCIDSK SDK (from GDAL 1.7.0)
PDS	PDS	No	Yes	Yes
PGDump	PostgreSQL SQL dump	Yes	Yes	Yes
PostgreSQL/PostGIS	PostgreSQL/ PostGIS	Yes	Yes	No, needs PostgreSQL client library (libpq)
EPIInfo .REC	REC	No	No	Yes
S-57 (ENC)	S57	No	Yes	Yes
SDTS	SDTS	No	Yes	Yes
Norwegian SOSI Standard	SOSI	No	Yes	No, needs FYBA library
SQLite/SpatiaLite	SQLite	Yes	Yes	No, needs libsqlite3 or libspatialite
SUA	SUA	No	Yes	Yes
SVG	SVG	No	Yes	No, needs libexpat
UK .NTF	UK. NTF	No	Yes	Yes
U.S. Census TIGER/Line	TIGER	No	Yes	Yes

OGR Vector Formats continued from previous page

Long Format Name	**Code**	**Creation**	**Georef.**	**Compiled by default**
VFK data	VFK	No	Yes	Yes
VRT - Virtual Datasource	VRT	No	Yes	Yes
OGC WFS (Web Feature Service)	WFS	Yes	Yes	No, needs libcurl
X-Plane/Flighgear aeronautical data	XPLANE	No	Yes	Yes

5.5 Sample Map files for MapServer

A basic map file

```
MAP #Start of map file
NAME "Washington Counties"
EXTENT 600000 -800000 2750000 1000000 # bounding box (map
      extent)
SIZE 600 300                          # size of output
     map in pixels
  LAYER # Data Layer object
    NAME Counties     # name of layer used as a reference
         by MapServer
    TYPE POLYGON      # spatial type
    STATUS DEFAULT    # status (on/off/default)
    DATA "../layers/counties2008"  # input data source (
         shapefile in this case)
    CLASS             # classification
      OUTLINECOLOR 100 100 100 # color for outline
           boundary
    END  # Class END
  END    # Data Layer END
END      # Map FileD
END
```

An intermediate map file

```
MAP # Start of map file
NAME "alliance"
EXTENT 630000 -540000 2700000 780000 # Bounding box
     coordinates in Projection set below (epsg:2285)
FONTSET "../../../fonts/fonts.txt"   # Fonts files for
     true type fonts
SIZE 400 400                         # output size of the
      map in pixels
UNITS FEET                           # map units
IMAGECOLOR 204 221 255               #
IMAGETYPE PNG                        # output file type
INTERLACE ON                         # enable interlacing
      for png image (faster loading)

        PROJECTION                          # start
            projection of the map
```

```
            "init=epsg:2285"                # epsg
                :2285 from epsg coming with Proj4 is
                 Washington Sate Plane North
    END                                  # projection
        end tag

LEGEND                              #
 keysize 15 15                      # size of legend
     boxes
 keyspacing 5 2                          # spacing
     between legend boxes
END                                 # legend end tag


# Start of web interface definition
    ##############################

WEB                                 # start general web
    definitions
    METADATA                             # Metadata tag
          start
  "wms_title" "Layers"              # name of WMS
      service, below location of the configuration map
      file
  "wms_onlineresource" "http://localhost/mapserver/
      mapserv.exe?map=d:/web/mapdata/projects/alliance/
      alliance.map"
  "wms_srs" "epsg:2285 epsg:4326"   # list of spatial
      reference systems, multiple entries enable
      multiple outputs to be requested
  "wms_feature_info_mime_type" "text/html"   # format of
       the GetFeatureInfo  request when identifying
      feature attributes
  "ows_enable_request"   "*"    # for MapServer version
      >= 6 WMS output needs to be enabled explicitly
    END                                  # end Metadata
          tag
END                                 # end tag general
    web definitions


# Start of symbol definitions
    ##################################
```

```
SYMBOL                                  # start vector
    symbol definitions
       NAME 'point'                           # name of
           symbol
       TYPE ELLIPSE                           # type of
           symbol
       POINTS 1 1 END                         # size
       FILLED TRUE                            # filled or
           not filled
END                                     # end  vector symbol
     definitions

# Start of layer definitions
    ###################################

 LAYER                                  # start layer tag
       NAME "States"                          # layer name
       TYPE POLYGON                           # layer type (
           POINT, LINE, POLYGON)
       STATUS ON                              # status (ON,
           OFF, DEFAULT)
       DATA "../wa_states"                    #
       TEMPLATE "templates/wa_states_template.html"     #
            location of query template in relative
           relation to map file location
       CLASS
                                       # start class
           definition
              COLOR 240 240 230

                                 # Color (in this case
                  polygon fill)
       END                                    # end class
           definitions
       DUMP true                                   #
           parameter that is required to enable WMS
           output
       PROJECTION                             # start
           projection of the layer
              "init=epsg:2285"                     # epsg
                  :2285 from epsg coming with Proj4 is
                   Washington Sate Plane North
       END                                      # layer
           projection end tag
```

```
        METADATA                                # Metadata tag
            start
      "wms_title" "States"             # name of this
          individual WMS layer
      "wms_srs" "epsg:2285 epsg:4326" # list of spatial
          reference systems this layer is available in
      "wms_feature_info_mime_type" "text/html"     #
          format of the GetFeatureInfo  request
      "ows_enable_request"   "*"  # for MapServer version
          >= 6 WMS output needs to be enabled exclicitly
        END                                         # Metadata
            tag start
 END                                    # end layer tag

##################################
END                                   # End of map file
```

A more complex map file with a PostGIS layer

```
MAP # Start of map file
NAME "alliance_all2"
EXTENT 630000 -540000 2700000 780000
FONTSET "/var/www/fonts/fonts.txt"
 SIZE 400 400
MAXSIZE 16384
UNITS FEET
IMAGECOLOR 204 221 255
IMAGETYPE PNG_1
# IMAGETYPE PNG
# INTERLACE ON

OUTPUTFORMAT
 NAME 'AGG'
 DRIVER AGG/PNG
 IMAGEMODE RGB
 FORMATOPTION "INTERLACE=ON"
END

OUTPUTFORMAT
 NAME 'AGG_Q'
 DRIVER AGG/PNG
 IMAGEMODE RGB
 FORMATOPTION "QUANTIZE_FORCE=ON"
 FORMATOPTION "QUANTIZE_DITHER=OFF"
 FORMATOPTION "QUANTIZE_COLORS=256"
 FORMATOPTION "INTERLACE=ON"
END

OUTPUTFORMAT
   NAME 'PNG_1'
   DRIVER "GD/PNG"
   MIMETYPE "image/png"
   IMAGEMODE PC256
   EXTENSION "png"
END

#### Start of projection definition ##################
# NAD83 / Washington North (ftUS) epsg <2285>
# PROJECTION
#    "proj=lcc"
#    "lat_1=48.73333333333333"
```

```
#    "lat_2=47.5"
#    "lat_0=47"
#    "lon_0=-120.8333333333333"
#    "x_0=500000.0001016001"
#    "y_0=0"
#    "ellps=GRS80"
#    "datum=NAD83"
#    "to_meter=0.3048006096012192"
# END
        PROJECTION
                "init=epsg:2285"
        END

LEGEND
 keysize 16 12
 keyspacing 5 2
 TRANSPARENT ON
   LABEL
                PARTIALS FALSE
      TYPE TRUETYPE
      FONT 'verdana'
      SIZE 8
      COLOR 1 1 1
   END
END


# Start of web interface definition
    ##############################

WEB
        HEADER "templates/general_header_template.html"
        FOOTER "templates/general_footer_template.html"
        ERROR  "http://alliance.terragis.net/
             mapserver_error.html"
        EMPTY  "http://alliance.terragis.net/query_empty.
             html"
        LOG    "/var/www/sites/mapbender/log/
             mapserver_ocla.log"
        METADATA
     "wms_title" "alliance_all"
     "wms_onlineresource" "http://alliance.terragis.net/
          cgi-bin/mapserv.fcgi?map=/var/www/mapdata/
          projects/alliance/alliance2.map"
```

```
    "wms_srs" "epsg:2285 epsg:4326"
    "wms_feature_info_mime_type" "text/html"
    "ows_enable_request"   "*"  # for MapServer version
        >= 6 WMS output needs to be enabled exclicitly
       END
END


# Start of symbol definitions
    ##################################
SYMBOL
       NAME 'point'
       TYPE ELLIPSE
       POINTS 1 1 END
       FILLED TRUE
END


# Start of layer definitions
    ##################################

 LAYER
       NAME "States"
       # GROUP "Boundaries"
       TYPE POLYGON
       STATUS ON
       DATA "mapdata/catalog/political/wa_states"
       HEADER "templates/table_header_template.html"
         FOOTER "templates/table_footer_template.html"
       TEMPLATE "templates/wa_states_template.html"
       CLASS
               COLOR 240 240 230
       END
       DUMP true
       METADATA
         "wms_title" "States"
         "wms_srs" "epsg:2285 epsg:4326"
         "wms_feature_info_mime_type" "text/html"
       END
  END

LAYER
       NAME "Topography"
       TYPE RASTER
```

```
        STATUS ON
        MINSCALE 500000
        DATA "mapdata/catalog/topography/wa_shade_1km.tif
            "
        TRANSPARENCY 15
  DUMP true
  METADATA
    "wms_title" "Topography"
    "wms_srs" "epsg:2285"
    "wms_feature_info_mime_type" "text/html"
  END
END

LAYER
        NAME "People_in_Institutions"
        # GROUP "Census 2000 (Counties)"
        TYPE POLYGON
        DATA "mapdata/projects/alliance/layers/counties"
        DUMP true
  METADATA
    "wms_title" "People_in_Institutions"
    "wms_srs" "epsg:2285 epsg:4326"
    "wms_feature_info_mime_type" "text/html"
        END

        HEADER "templates/table_header_template.html"
        FOOTER "templates/table_footer_template.html"
        TEMPLATE "templates/
            county_people_in_institutions_template.html"
        TOLERANCE 0
        STATUS OFF
        # MINSCALE 1000000
        MAXSCALE 3500000
        CLASS
                NAME "Up to 400"
                EXPRESSION ([INSTITUTN] >= 31 AND [
                    INSTITUTN] <= 400)
                STYLE
                        COLOR 112 153 89
                END
        END
        CLASS
                NAME "401 - 1,500"
```

```
            EXPRESSION ([INSTITUTN] > 400 AND [
                INSTITUTN] <= 1500)
            STYLE
                COLOR 178 194 141
            END
        END
        CLASS
            NAME "1,501 - 4,000"
            EXPRESSION ([INSTITUTN] > 1500 AND [
                INSTITUTN] <= 4000)
            STYLE
                COLOR 255 240 204
            END
        END
        CLASS
            NAME "4,001 - 8,500"
            EXPRESSION ([INSTITUTN] > 4000 AND [
                INSTITUTN] <= 8500)
            STYLE
                COLOR 255 153 153
            END
        END
        CLASS
            NAME "More than 8.500"
            EXPRESSION ([INSTITUTN] > 8500)
            STYLE
                COLOR 230 0 0
            END
        END
END

LAYER
        NAME "Census Tracts Query"
  CONNECTIONTYPE postgis
  CONNECTION "user=test password=test dbname=test host=
      localhost"
  PROCESSING "CLOSE_CONNECTION=DEFER"
  DATA "the_geom from (select the_geom, id, fipsstco,
      trt2000, stfid, tractid, area, acres, sq_miles,
      pop_100, name, gid from wa_tracts %
      replacementvalue%) as temp using unique gid using
      SRID=2285"
        TYPE POLYGON
  # TRANSPARENCY 50
```

```
        STATUS ON
        HEADER "templates/table_header_template.html"
        FOOTER "templates/table_footer_template.html"
  TEMPLATE "templates/county_template.html"
        DUMP true
        METADATA
    "wms_title" "Census_Tracts_Query"
    "wms_srs" "epsg:2285"
    "gml_featureid" "id"
    "gml_include_items" "all" #optional (gives all
        available parameters back
        END
        CLASS
                NAME "tracts"
                STYLE
                        COLOR 0 38 115
                END
                STYLE
                        SYMBOL "POINT"
                        SIZE  0
                        OUTLINECOLOR 110 110 110
                END
        END
END

END # Map File
```

A map file layer with a raster tile index

```
# Start of layer definitions
    ##################################
LAYER
        NAME "Orthos2008"
        TILEINDEX "/data/ortho_image_index"  # shapefile
            of the raster tile extents\
        # can be produced using gdaltindex  (builds a
            shapefile with a record for each input
            raster file , an attribute containing the
            file name, and a polygon geometry outlining
            the raster.)
        TILEITEM "location"  # attribute containing the
            file name (in dbf file)
        TYPE RASTER
        STATUS OFF
```

```
        PROJECTION
                "init=esri:4326"
        END
        DUMP true
        METADATA
    "wms_title" "Orthos2008"
    "wms_srs" "epsg:4326 epsg:3857"
    "wms_feature_info_mime_type" "text/html"
    "ows_enable_request"    "*"  # for MapServer version
         >= 6 WMS output needs to be enabled explicitly
        END
END
```

5.6 OpenLayers Viewer: Examples OL 2

Commercial background layers and MapServer WMS

Note that this example using Google maps v3.2 (work with OpenLayers 2.10 and higher). Compare the example on the DVD: data/openlayers/**ol_map_simple.html**.

```
<html>
  <head>
    <title>MapServer WMS Layer on Top of Commercial maps</title>
    <script src="../openlayers/OpenLayers.js"></script>
    <script src="http://maps.google.com/maps/api/js?v=3.2&sensor=false"></
        script>
    <script type="text/javascript">
      var map;
      var options = {
          projection: new OpenLayers.Projection("EPSG:3857"),
          units: "m",
          maxResolution: 156543.0339,
          maxExtent: new OpenLayers.Bounds(-13776237, 5870705,
              -13270618,6177605)
      };

      window.onload = function(){
        map = new OpenLayers.Map( 'map', options );
        var Counties = new OpenLayers.Layer.WMS( "counties",
                "/cgi-bin/mapserv.exe?map=C:/class/data/mapfiles/
                    wacounties_wms.map", {layers: 'Counties', 'transparent':
                    true}, {isBaseLayer: false, 'opacity': 0.7, 'visibility':
                    false, singleTile:true} );
        var Rail = new OpenLayers.Layer.WMS( "rail",
                "/cgi-bin/mapserv.exe?map=C:/class/data/mapfiles/
                    wacounties_wms.map", {layers: 'Rail', 'transparent': true
                    }, {isBaseLayer: false, 'opacity': 0.7, 'visibility': true
                    , singleTile:true} );
        var Cities = new OpenLayers.Layer.WMS( "cities",
                "/cgi-bin/mapserv.exe?map=C:/class/data/mapfiles/
                    wacounties_wms.map", {layers: 'Cities', 'transparent':
                    true}, {isBaseLayer: false, 'opacity': 0.7, 'visibility':
                    false, singleTile:true} );
        var Uninhabited = new OpenLayers.Layer.WMS( "uninhabited",
                  "/cgi-bin/mapserv.exe?map=C:/class/data/mapfiles/
                      wacounties_wms.map", {layers: 'Uninhabited', '
```

```
                    transparent': true}, {isBaseLayer: false, 'opacity':
                    0.7, 'visibility': false, singleTile:true} );

        var base_empty = new OpenLayers.Layer("No Background", {isBaseLayer:
            true, numZoomLevels: 20, 'displayInLayerSwitcher': true, basename:
             "empty"});
        map.addLayer(base_empty);
        var g_street    = new OpenLayers.Layer.Google("Google Streets"   ,{'
            maxZoomLevel':20} ); map.addLayer(g_street);
        var g_satellite = new OpenLayers.Layer.Google("Google Satellite" ,{
            type: google.maps.MapTypeId.SATELLITE, 'maxZoomLevel':20} );
        var g_hybrid    = new OpenLayers.Layer.Google("Google Hybrid"    ,{
            type: google.maps.MapTypeId.HYBRID,    'maxZoomLevel':20} );
        var g_physical  = new OpenLayers.Layer.Google("Google Physical"  ,{
            type: google.maps.MapTypeId.TERRAIN,   'maxZoomLevel':20} );
        map.addLayers([g_street,g_hybrid,g_satellite,g_physical,base_empty,
            Uninhabited,Cities,Rail,Counties]);

        var bounds = new OpenLayers.Bounds(-13776237, 5870705, -13270618,
            6177605);
        map.zoomToExtent(bounds);

        map.addControl( new OpenLayers.Control.LayerSwitcher() );
        mp=new OpenLayers.Control.MousePosition();

        mp.displayProjection = new OpenLayers.Projection( "EPSG:3857" );
        map.addControl(mp);
      }; // end bracket of window.onload function
    </script>
  </head>
  <body>
    <div id="title"> <h1 class="style2">Simple OL Map - OS Web GIS Class</h1
        ></div>
    <div id="map"></div>
  </body>
</html>
```

Commercial layers in OpenLayers 2

Below are some HTML/Javascript code snippets to illustrate how to add commercial layers to an OpenLayers map. For a full example file look at **/data/openlayers/alllayers.html** on the DVD.

```
<!-- MapQuest Layer -->
```

```
OpenLayers.Layer.MapQuestOSM = OpenLayers.Class(OpenLayers.Layer.XYZ, {
      name: "MapQuestOSM",
      //attribution: "Data CC-By-SA by <a href='http://openstreetmap.org/'>
          OpenStreetMap</a>",
      sphericalMercator: true,
      url: ' http://otile1.mqcdn.com/tiles/1.0.0/osm/${z}/${x}/${y}.png',
      clone: function(obj) {
          if (obj === null) {
              obj = new OpenLayers.Layer.OSM(
              this.name, this.url, this.getOptions());
          }
          obj = OpenLayers.Layer.XYZ.prototype.clone.apply(this, [obj]);
          return obj;
      },
      CLASS_NAME: "OpenLayers.Layer.MapQuestOSM"
  });

<!-- Bing Layers -->
  // API key for http://openlayers.org. Please get your own at
  // http://bingmapsportal.com/ and use that instead.
  var BingApiKey = "
      AqTGBsziZHIJYYxgivLBf0hVdrAk9mWO5cQcb8Yux8sW5M8c8opEC2lZqKR1ZZXf";
  var b_street = new OpenLayers.Layer.Bing({key: BingApiKey, type: "Road",name
      : "Bing Roads map"});
  b_street.buffer = 0; map.addLayer(b_street);
  var b_satellite = new OpenLayers.Layer.Bing({key: BingApiKey,type: "Aerial",
      name: "Bing Aerial"});
  b_satellite.buffer = 0; map.addLayer(b_satellite);
  var b_hybrid = new OpenLayers.Layer.Bing({key: BingApiKey,type: "
      AerialWithLabels",name: "Bing Hybrid"});
  b_hybrid.buffer = 0; map.addLayer(b_hybrid);


<!-- Open Street Map Layer -->
  var mapnik      = new OpenLayers.Layer.OSM("Open Street Map");
        mapnik.buffer = 0; map.addLayer(mapnik);

<!-- Google V3 API  Layers -->

<html>
   <head>
     <!-- include the Google V3.2 API , no key needed but still need to
          include the API-->
```

```
 <script src="http://maps.google.com/maps/api/js?sensor=false&v=3.2"></
     script>
 <script type="text/javascript" src="../../lib/OpenLayers−2.10/OpenLayers.
     js"></script>
 <script type="text/javascript" >

var g_streets = new OpenLayers.Layer.Google(
"Google Roads", // the default
{numZoomLevels: 20}
// default type, no change needed here);

var g_satellite = new OpenLayers.Layer.Google(
"Google Satellite",
{type: google.maps.MapTypeId.SATELLITE, numZoomLevels: 22}
// in OL 2.9 and Google v2 this used to be {type: G_SATELLITE_MAP,
    numZoomLevels: 22});
g_satellite.buffer = 0; map.addLayer(g_satellite); // add to map no tile
    buffer

var g_hybrid = new OpenLayers.Layer.Google(
"Google Hybrid",
{type: google.maps.MapTypeId.HYBRID, numZoomLevels: 20}
// in OL 2.9 and Google v2 this used to be {type: G_HYBRID_MAP,
    numZoomLevels: 20});
g_hybrid.buffer = 0; map.addLayer(g_hybrid); // add to map no tile buffer

var g_terrain = new OpenLayers.Layer.Google(
"Google Terrain",
{type: google.maps.MapTypeId.TERRAIN}
// in OL 2.9 and Google v2 this used to be {type: G_PHYSICAL_MAP});
 </script>
</head>
</html>
```

OpenLayers examples included on the class DVD

A long list of general OL examples can be found here for OL 2.X and here for OL 3. Another interesting web page with OpenLayers 2 examples can be found here. There are five examples included on the DVD in the **/data/openlayers/identify** directory:

- **map.html** Identify office location point features on the map (often multiple in one location); display attributes using a MapServer query template (compare code listing in the next section). If you like to implement this example locally you can import the *location* point data from the DVD *data/layers/officelocations.shp* into PostGIS using shp2pgsql. View live example here.
- **map_controls.html** Example of multiple controls in OL: edit tool bar, scale bar, and navigation tool bar (pan and zoom). The navigation tool bar is placed in a <div> tag to change it's position (located outside the right upper corner of the map). View live example here.
- **map_dynamic.html** Demo of a dynamic MapServer layer. Click on the map to highlight a County. This is a server side implementation and uses the dynamic (PostGIS based) MapServer Layer *querylayer* in query.map. Clicking on a County on the map triggers an Ajax call and runs a query to PostGIS (via the *getCounty.php* script) to retrieve the County name. This value is then used for the replacement variable updating the dynamic layer in OL. Sounds tricky doesn't it? But this set-up enables any functionality to be run on the retrieved feature on the server side in PostGIS, including analysis like buffers and intersections or any custom function you may want to write in PL/pgSQL. View live example here.
- **map_staticbuffer.html** Similar to *map_dynamic.html*, but also buffers the County feature geometry before highlighting on the map. View live example here.
- **alllayers.html** Example file with many base layers at once: Google (v3.2), Bing, Open Street Map, and MapQuest. Compare the code snippets for the individual map layer on page 108. View live example here.

Map files and OL style sheet used with the above examples:

- **style.css** OL standard style sheet
- **query.map** map file with two dynamic layers called *querylayer* and *bufferlayer* (including a MapServer replacement variable
- **identify.map** map file with a point layer of office *locations* with specified MapServer query templates, e.g. locations_template.html
- **getCounty.php** returns the County name from the *counties* layer in PostGIS

Below is a list of the MapServer query templates used in **map.html** (for retrieving the identified feature attributes and styling of the output). When running a query, all of the template below are assembled (in the listed sequence) at runtime by MapServer. The result is a HTML table including the results.

```
locations_template.html
general_header_template.html
table_header_template.html
table_footer_template.html
general_footer_template.html
```

Code Listing for map.html: Example for identifying attributes in OL (getfeatureinfo request)

This example is included on the DVD **/data/OpenLayers/identify/map.html** along with the map file **identify.map**.

```
 <html>
<head>
   <title>Template Example</title>
   <style type="text/css">
         #mapandlegend {
      width: 940;
      height: 650;
      position:relative;
   }
   #map {
      width: 700;
      height: 600;
      border: 1px solid black;
   }
               #thelegend {
      width: 220;
      height: 100;
      border: 1px solid black;
      padding: 12px;
      position:absolute;
      top:0px;
      right:-10px;
   }
               #results {
      width: 220;
      height: 160;
      right: 0;
      position:absolute;
      top:140px;
      font-size: 10 pt;
```

```
    font: 10 pt "Lucida Grande", Verdana, Lucida, Helvetica, Arial, sans-
        serif;
}
</style>
<script src="../../OpenLayers.js"></script>
<script type="text/javascript">
    var map;
    var options = {
                                    maxResolution: 898,
        projection: new OpenLayers.Projection("EPSG:2285"),
        units: "m",
        tileSize: new OpenLayers.Size(256, 256),
        maxExtent: new OpenLayers.Bounds(680000,-150000,1600000,740000)
    };

    window.onload = function(){
      map = new OpenLayers.Map( 'map', options );

      var base = new OpenLayers.Layer.WMS("Base Map",
                "http://alliance.terragis.net/cgi-bin/mapserv?map=/var/www
                    /mapdata/projects/alliance/alliance2.map", {layers: '
                    States,Puget_Sound,Counties,Cities,Roads,Lakes,Rivers,
                    Major_City_Names,Main_City_Names,City_Names', '
                    transparent': true}, {isBaseLayer:true, 'opacity': 1,
                    'visibility': true, singleTile:true} );

      var locations = new OpenLayers.Layer.WMS( "Office Locations",
                "http://localhost/cgi-bin/mapserv.exe?map=C:/class/data/
                    mapfiles/identify.map", {layers: 'locations', '
                    transparent': true, 'WEBSQL':'roads'}, {isBaseLayer:
                    false, 'opacity': 0.7, 'visibility': false, singleTile
                    :true} );

        var bounds = new OpenLayers.Bounds(680000,-150000,1600000,740000);
        map.addLayers([base,locations]);
        map.zoomToExtent(bounds);
        map.addControl( new OpenLayers.Control.LayerSwitcher() );
        mp=new OpenLayers.Control.MousePosition();
        mp.displayProjection = new OpenLayers.Projection("EPSG:2285");
        map.addControl(mp);

        map.events.register('click', map, function (e) {
        OpenLayers.Util.getElement('results').innerHTML = "One second...";
        var url =  locations.getFullRequestString({
```

```
                                REQUEST: "GetFeatureInfo",
                                EXCEPTIONS: "application/vnd.ogc.se_xml",
                                BBOX: locations.map.getExtent().toBBOX(),
                                X: e.xy.x,
                                Y: e.xy.y,
                                INFO_FORMAT: 'text/html',
                                MODE: 'nquery',
                                FEATURE_COUNT: 2,
                                QUERY_LAYERS: locations.params.LAYERS,
                                WIDTH: locations.map.size.w,
                                HEIGHT: locations.map.size.h});
            OpenLayers.loadURL(url, '', this, setHTML);
            OpenLayers.Event.stop(e);
        })

        }

        function setHTML(response) {
        OpenLayers.Util.getElement('results').innerHTML = response.
            responseText;
        }
    </script>
  </head>
  <body><div id="title">Template Example - Office Location Map</div>
  <div id="mapandlegend">
  <div id="map"></div>
      <div id="thelegend"><span class="style1">Offices</span>
        <div><img src="http://localhost/cgi-bin/mapserv.exe?map=C:/class/data/
            mapfiles/identify.map&version=1.1.1&service=WMS&request=
            GetLegendGraphic&layer=locations&format=image/png" alt="Offices
            "></div>
        <div>
        </div>
        <div id="results"></div>
        </div>
  </body>
</html>


    </script>
  </head>
  <body><div id="title">Template Example - Office Location Map</div>
  <div id="mapandlegend">
  <div id="map"></div>
      <div id="thelegend"><span class="style1">Offices</span>
```

```
        <div><img src="http://orca.terragis.net/cgi-bin/mapserv?map=/var/www/
            mapdata/projects/examples/identify.map&version=1.1.1&service=WMS&
            request=GetLegendGraphic&layer=locations&format=image/png" alt="
            Offices"></div>
        <div>
        </div>
        <div id="results"></div>
        </div>
  </body>
</html>
```

Example for using TileCache layers in OpenLayers 2

A description for installing TileCache can be found here: `http://tilecache.org` The following lines of code illustrate how TileCache based layers can be added to the JavaScript section in the OL web page:

```
var wms_basemap_tiles = new OpenLayers.Layer.WMS("Base tiled", "http://
    localhost/tilecache/tilecache.py", {layers: 'mymap_base', 'transparent':
    true}, {isBaseLayer:true, 'opacity': 1, 'visibility': true, singleTile:
    false} );
var wms_images_tiles = new OpenLayers.Layer.WMS("Images tiled", "http://
    localhost/tilecache/tilecache.py", {layers: 'mymap_images', 'transparent':
     true}, {isBaseLayer:true, 'opacity': 1, 'visibility': true, singleTile:
    false} );
var wms_raster_catalog = new OpenLayers.Layer.WMS("Images 2008", "http://
    localhost/cgi-bin/mapserv?map=/mnt/maps/mymap.map", {layers: 'Orthos2008',
     'transparent': true}, {isBaseLayer:true, 'opacity': 1, 'visibility': true
    , singleTile:false} );
```

The snippet below shows the configuration of one of the above TileCache layers **mymap_base** in tilecache.cfg (the TC configuration file). The value for *maxresolution* can be determined as follows: Take your *maxExtent* and find the width of it in map units. This is literally the value of east minus the west in our case below:

> **-117.115453 - (-117.459654) = 0.344201 degrees**

Now we need to divide the width by the number of pixels in which it should be rendered. Given that a tile defaults to 256x256, this means that dividing the width by 256 would fit the entire map into 1 tile. Dividing by 1024 (256*4) fits it into 4 tiles. Example:

> **0.344201 / 1024 = 0.000672267578125**

The value above is the **maxResolution** for our example. This should be used in the definition on the OpenLayers page. In tilecache.cfg this value needs to be entered along with the **maxExtent** and the **numZoomLevels** (number of zoom levels):

[mymap_base] type=WMS
metaTile=true
url=http://localhost/cgi-bin/mapserv?map=/maps/mymap.map
srs=EPSG:4326
layers=Ocean,Parks,Landmarks,Lakes,Rivers,Lagoons,Roads,Railway,Citynames
bbox=-117.459654,32.960546,-117.115453,33.282610
maxresolution = 0.0003361337890625
levels=7
extent_type=loose

5.7 PAQs: Participant Asked Questions

How can the output of the MapServer legend be styled?

The LEGEND definition in the map file gives you a fair amount of customization options such as label font, font size, key icon width and height etc. Images can be used for the legend by specifying the KEYIMAGE parameter in the CLASS object.

```
LEGEND
 keysize 16 12   # width and height of generated icon
 keyspacing 5 2  # spacing between icons
 TRANSPARENT ON  # background set transparent
   LABEL            # Label tag
      TYPE TRUETYPE  # Font category
      FONT 'verdana' # Font (needs to be installed and
           path known to mapserver
      SIZE 8         # Font Size
      COLOR 1 1 1    # RGB color value
   END
END
```

Another option is to use MapServer HTML templates instead of the legend graphics (gif format) generated by default. A simple solution is to incorporate a HTTP GetLegendGraphic request as a HTML image source tag into our web page or application. More information at mapserver.org.

Which charting tools are available for use in my web application?

One simple option are the **MapServer Chart layers**. They provide simple Pie and Bar charts and are easily configured. Pie Charts are the default chart type. This can also be set by typing

```
PROCESSING "CHART_TYPE=PIE"
```

In the following example (taken from the MapServer documentation) for each shape in the layer's data source, the STYLE SIZE is used to set the relative size (value) of each pie slice, with the angles of the slices that are automatically computed so as to form a full pie:

```
LAYER
    NAME "Ages"
    TYPE CHART
    CONNECTIONTYPE postgis
    CONNECTION "blabla"
    DATA "the_geom from demo"
    PROCESSING "CHART_TYPE=pie"
    PROCESSING "CHART_SIZE=30"
    STATUS ON
    CLASS
```

```
        NAME "Population Age 0–19"
        STYLE
            SIZE [v1006]
            COLOR 255 244 237
        END
    END
    CLASS
        NAME "Population Age 20–39"
        STYLE
            SIZE [v1007]
            COLOR 255 217 191
        END
    END
    CLASS
        NAME "Population Age 40–59"
        STYLE
            SIZE [v1008]
            COLOR 255 186 140
        END
    END
END
```

In the example above, if for a given shape we have v1006=1000, v1007=600 and v1008=400 then the actual pie slices for each class will be respectively 50, 30 and 20 percent of the total pie size.

Here are three more options to explore:
In MS4W **OWTchart** a CGI based solution is included: http://www.maptools.org/owtchart. "The OWTChart Engine produces GIF images of virtually any type of chart from a set of input parameters. The program can be used as a CGI in a web server environment, in which case it will return a GIF image with the chart built from the parameters found in the QUERY_STRING part of the URL, or from the body of a POST request."

How can we connect from MapServer to MS SQL Server 2008?

Answer: via a MapServer plug-in. This example is taken from http://mapserver.org/development/rfc/ms-rfc-38.html?highlight=sql%20servermapserver.org

```
LAYER
  NAME "Roads"
  CONNECTIONTYPE PLUGIN
  PLUGIN "C:\class\software\ms4w\Apache\specialplugins\
      msplugin_mssql2008.dll"
```

```
  CONNECTION "server=mysqlserver2008.com;uid=dbusername;
       pwd=dbpassword;database=Roads Database;Integrated
       Security=false"
  DATA "the_geom from roads"
  TYPE LINE
  STATUS ON
  PROJECTION
      "init=epsg:4326"
  END
  CLASS
    STYLE
       COLOR 0 0 255
       WIDTH 8
     END
  END
END
```

How can we join data from a DBF file to a shapefile in MapServer?

Below is an example of a shapefile based map layer including a one-to-many join of *legal service provider offices (DBF file)* to a *region polygon shapefile* (one region with multiple legal aid providers that can have multiple offices each). The following query templates are used (included on the DVD in **data/templates/join**):

```
table_header_template.html
table_footer_template.html
region_sum_template.html
region_providers_officelist_template.html
```

```
LAYER
        NAME "Providers_Regions"
        TYPE POLYGON
        DATA "mapdata/projects/alliance/layers/region_sum
            "
        HEADER "templates/table_header_template.html"
        FOOTER "templates/table_footer_template.html"
  TEMPLATE "templates/region_sum_template.html"
  JOIN
     NAME officelist
     TABLE "mapdata/projects/alliance/layers/
          region_providers_officelist.dbf"
     FROM REG_ID
```

```
    TO REG_ID
    TYPE one-to-many
    TEMPLATE "templates/
        region_providers_officelist_template.html"
  END
        TOLERANCE 0
        STATUS OFF
        CLASS
                NAME "Providers by Region (2007)"
                STYLE
                END
                STYLE
                        SYMBOL "POINT"
                        SIZE   4
                        OUTLINECOLOR 000 000 031
                END
        END
        METADATA
    "wms_title" "Providers_Regions"
    "wms_srs" "epsg:2285 epsg:4326"
    "wms_feature_info_mime_type" "text/html"
        END
END
```

Below are listings of the two template files involved.

```
<!-- MapServer Template -->
<!--region_providers_officelist_template.html-->
<tr><td style="width: 50px">[officelist_FTE_MAP] FTE</td>
    <td>[officelist_NAME] [officelist_OFFICENAM], [
    officelist_STREET] [officelist_SUITE], [
    officelist_CITY], [officelist_STATE] [officelist_ZIP
    ]</td></tr>

<!-- MapServer Template -->
<!--region_sum_template.html-->
<tr><th colspan="3">Provider FTE</th><th>Region [REG_ID]
    "[REGION]"</th></tr>
<tr><td colspan="3">Number of Attorneys in Region "[
    REGION]"</td><td align="center">[SUM_ATTORN] </td></
    tr>
<tr><td colspan="3">FTE sum</td><td align="center">[
    PROVIDER_S] </td></tr>
<tr><td colspan="3">Northwest Justice Project</td><td
    align="center">[NWJP] </td></tr>
```

```
<tr><td colspan="3">Columbia Legal Services</td><td align
    ="center">[CLS] </td></tr>
<tr><td colspan="3">Pro Bono FTE equivalents</td><td
    align="center">[PROBONO] </td></tr>
<tr><td colspan="3">Mediation Services</td><td align="
    center"> not available</td></tr>
<tr><td colspan="3">CLEAR FTE equivalents</td><td align="
    center">[CLEAR_FTE] </td></tr>
<tr><td colspan="3">Specialty Legal Aid Providers </td><
    td align="center">[SPECIALTY]</td></tr>
[join_officelist]
```

How can we create a dynamic layer with MapServer and PostGIS?

Below is an example of a (MapServer map file) layer definition using a MapServer replacement variable (embedded in "%" strings). MapServer will replace the variable with itś value when the layer is requested at run time. For example you can use a variable you retrieved via a query against a PostGIS database via a PHP POST request to your server. Note that the variable value can be any string that PostGIS can handle in a SQL query, including all PostGIS functions. Working with OpenLayers the *mergeNewParams* method can be called on the map layer (see below) to update a layer dynamically. To avoid any MapServer errors initially set the replacement variable to a SQL string that evaluates to retrieve zero features (nothing displayed for the query layer on the map initially). Make sure to use uppercase characters for the variable name in the map file and the OL page (this is necessary in order to have the variable names match exactly because OL converts the params to all uppercase).

In a map file you can define a dynamic, PostGIS based layer similar to this:

```
LAYER
        NAME "querylayer"
        GROUP "querylayer"
        TYPE POLYGON
        STATUS ON
  METADATA
         "wms_title" "querylayer"
         "wms_srs" "epsg:2285 epsg:4326"
         "wms_feature_info_mime_type" "text/html"
  END
  DUMP true
  CONNECTIONTYPE postgis
  CONNECTION "user=postgres password=postgres dbname=
      osgis host=localhost"
  DATA "the_geom from (%WEBSQL%) as subquery using unique
       gid using SRID=2285"
  # %WEBSQL% will be replaced at run time by MapServer.
      with the string containing the subquery syntax to
      PostGIS
  # e.g. "select * from counties where name ilike 'King'"
  # this translates at runtime to the full statement:
  # DATA "the_geom from (select * from counties where
      name ilike 'King') as subquery using unique gid
      using SRID=2285"
  DUMP true
        CLASS
                NAME "Query Result"
    STYLE
                        OUTLINECOLOR 255 0 0
```

```
                                WIDTH 3
  END
 END
END
```

In the OL page include the dynamic layer, and an *update function* (and call the update function when appropriate):

```
querylayer = new OpenLayers.Layer.WMS( "Locations", "http://orca.terragis.net/
     cgi-bin/mapserv?map=/var/www/mapdata/projects/examples/identify.map&", {
     layers: 'querylayer', 'transparent': true, 'WEBSQL':'counties where 1 =
     0'}, {isBaseLayer: false, 'opacity': 0.7, 'visibility': true, singleTile:
     true} );

// merge parameter from the PHP post: call udpate() function for this
update_query();

function update_query() {
    var querystring = "<?PHP echo $mapquery; ?>";
    querylayer.mergeNewParams({'WEBSQL':querystring});
}
```

Using this set-up you can even write your own pgSQL functions for use with the MapServer replacement variable. There are virtually no limits to use this ...

Can I use ESRI File Geodatabases as input for MapServer?

Read access to ESRI file geodatabases is supported via OGR (the software version needs to be GDAL version >= 1.9). Note two main requirements: Only file geodatabases created by ArcGIS version 10.0 can be used read, and your GDAL/OGR software build needs to contains the file geodatabase *FileGDB* driver. For more information see http://mapserver.org/input/vector/filegdb.html Below is an example for a map file with a file geodatabase layer.

```
LAYER
  NAME "fgdb_poly"
  TYPE POLYGON
  STATUS OFF
  CONNECTIONTYPE OGR
  CONNECTION "../data/filegdb/us_states.gdb"
  DATA "statesp020"
  LABELITEM "US STATE"
  CLASS
    NAME "US States"
    STYLE
      COLOR 255 120 120
      OUTLINECOLOR 0 0 0
    END
    LABEL
      COLOR 255 255 255
      OUTLINECOLOR 0 0 0
    END
  END
END
```

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